ENVIRONMENTAL IMPACT STATEMENT

FINAL

MONTANA AMBIENT AIR QUALITY STANDARDS

Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

AIR QUALITY BUREAU
Cogswell Building
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A. C. Knight, M.D., F.C.C.P.
Director

February 14, 1980

TO: INTERESTED PERSONS

This is the final Environmental Impact Statement on the Montana Ambient Air Quality Standards Study. Copies of this impact statement are being sent to persons who filed comments on the draft environmental impact statement as well as to all the major libraries in the state.

Issuance of this final Environmental Impact Statement commences the process of rulemaking by the Board of Health and Environmental Sciences under the Montana Administrative Prodecure Act. A description of the upcoming rulemaking process is provided in the Preface of this document.

Persons desiring information about the library availability of the impact statement or wishing to obtain a copy of the impact statement may contact the Department of Health and Environmental Sciences, Air Quality Bureau, in Helena, at 406-449-3454.

The Department wishes to thank all those persons who contributed their interest and information to the EIS process.

Sincerely,

MD Roach

Michael D. Roach, Chief
Air Quality Bureau

MONTANA AMBIENT AIR QUALITY STANDARDS STUDY

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PREFACE

The following discussion is included to explain the rulemaking procedure to be followed by the Board of Health and Environmental Sciences in adopting rules on ambient air quality standards. The explanation is presented so that all interested persons are fully informed about the respective roles they may play in that process.

RULEMAKING UNDER THE ADMINISTRATIVE PROCEDURE ACT

The issuance of this final environmental impact statement commences the process of rulemaking by the Board of Health and Environmental Sciences under the Montana Administrative Procedure Act. The Board has adopted a special procedural rule governing the rulemaking process leading to the adoption of new ambient air quality standards. A copy of this procedural rule is provided as Appendix B.

The procedural rule establishes a "paper hearing" in which scientific and technical experts and persons or organizations concerned with air quality policy (designated in the rule as "parties") will participate in the rulemaking process by filing written testimony with the Board. The parties will also file their statements with each other by means of a service list. Members of the general public are invited to present their comments during public hearings to be held in May.

The paper hearing commences with the publication of this final environmental impact statement containing the Department's recommendations to the Board. Then, a period of approximately three months is provided for interested

parties (scientific and policy witnesses) to file opening and response statements with the Board and with other parties on the service list. Soon thereafter, the Board will conduct public hearings to receive public comment on the Department's proposals.

The Board will hold a hearing in Helena to receive public comment and, if the Board finds it necessary, scientific and policy witnesses will be requested to appear at the hearing in Helena to clarify or expand upon their prefiled statements. Because of the interest in air quality that has been expressed, the Board also will hold hearings in Billings and Missoula to receive comments from the general public.

After the public hearings, a period of forty-five days is provided for the parties in the paper hearing to file rebuttal statements with the Board and with other parties on the service list. Upon the conclusion of the rebuttal period the Board will complete its deliberations and will adopt rules on ambient air quality standards.

PARTICIPATION IN THE RULEMAKING PROCESS

According to the special procedural rule adopted by the Board, the "paper hearing" is designed for persons with recognized experience in air pollution related fields and for persons, groups, or organizations concerned with public policy. Persons who participate in the paper hearing by filing written statements with the Board and with others on the service list must describe their education and experience and must accompany their statements with a 100-word summary. Many such persons and organizations have already expressed their interest in the MAAQSS process by filing comments on the draft EIS. The Department has provided the hearings examiner with a list of these parties. These parties, along with certain other persons and organizations who have requested information on the rulemaking process, currently constitute the service list for the paper hearing.

Other persons who wish to participate in the paper hearing should contact the hearings examiner as soon as possible but no later than March 4, 1980.

In order that members of the general public have the opportunity to familiarize themselves with materials filed in the paper hearing, certain public libraries in different regions of the state will be included on the service list as repositories. Copies of materials filed by parties during the paper hearing will be mailed to these libraries for public reference. The locations of these libraries will be provided in newspaper notices subsequent to issuance of this final EIS.

Members of the general public presenting their views at public hearings are encouraged, if possible, to summarize their remarks in writing and provide copies to the hearings examiner. Written statements are not required and oral testimony unaccompanied by written summaries will be received. However, written statements serve to facilitate the presentation of public comment to the seven Board members and therefore are encouraged.

Persons not appearing at a public hearing who wish to mail in their comments to the hearings examiner are also encouraged to accompany their statements with several copies.

The Board has scheduled public hearings for the following times and locations:

May 7, 1980	Library Room 231 Eastern Montana College Billings, Montana	7:00-11:00 p.m.
May 8, 1980	Missoula County High School Auditorium Hellgate High School Missoula, Montana	7:00-11:00 p.m.
May 27-31, 1980 as necessary	Department of Highways Auditorium 2701 Prospect Avenue Helena, Montana	9:00 a.m. each day

Additional notices of these hearings will be published in major newspapers in the state. The hearings examiner designated by the Board for the rulemaking procedure is C. W. Leaphart, Jr., Esq., One North Last Chance Gulch, Helena, Montana, 59601.

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I. SUMMARY

In the fall of 1977 the Montana Department of Health and Environmental Sciences (DHES) was considering enforcement action against some Montana industries for violations of the administrative regulation on Ambient Air Quality Standards (ARM 16-2.14(1)-S14140). This rule had been on the books more than ten years and had been regarded during that time as an enforceable regulation. During the research in preparation for the enforcement action, however, it was discovered that there was some doubt whether the Board of Health and Environmental Sciences had adopted the standards with the intent that they be enforceable.

When advised of the uncertain status of the Montana Ambient Air Quality Standards, the Board indicated it wanted the state to have enforceable standards. It was decided that before such standards were adopted anew, there should be a thorough review to determine whether the old standards were still appropriate or whether scientific research completed since their adoption indicated different standards were needed.

The process followed by the Department in determining the proposed standards may be summarized as follows:

1. Compilation and Assessment of Scientific and Factual Information

The Department first reviewed the scientific literature on the health effects of pollutants found in Montana. Information was also assembled regarding the various pollution sources within the state.

2. Determination of Which Pollutants to Regulate

The Department selected for regulation those pollutants currently

occurring in significant levels in the state and for which there was scientific evidence to derive a meaningful standard. These include sulfur dioxide, total suspended particulate, settleable particulate, lead, carbon monoxide, fluorides, nitrogen dioxide, photochemical oxidants, hydrogen sulfide and visibility. Several portions of the current ambient rule were recommended for deletion. These included the ambient standards for beryllium, acid mist, and suspended sulfate, and the calcium borate and sulfate plate methods of sampling.

The data were judged insufficient to support standards for arsenic, cadmium, polycyclic organic matter, beryllium, respirable particles, suspended sulfate, and sulfuric acid mist. Therefore, no standards were proposed for these. The Department decided to continue reviewing new research results as they become available, with the commitment to recommend additional standards when appropriate.

3. Determining the Level of Apparent Health Response

The Department relied on scientific information to establish for each pollutant a level which apparently was sufficient to produce a detectable health response in the most sensitive persons.

4. Once the level of apparent health response was established, the Department assessed the risk associated with effects of the pollutant. Several considerations were weighed to determine what level of risk was acceptable without jeopardizing public health. This determination indicated the stringency necessary to compensate for uncertainties as to what exposures were safe.

5. Considerations Above and Beyond Health to Determine Final Standard to be Proposed

Once the health standard was determined, the Department reviewed

the scientific evidence to determine whether the pollutant would have effects upon the state's economic and social welfare at concentrations more dilute than the level required to protect health. Where such effects were likely to occur, they were weighed against the other specific welfare interests specified in the Montana Clean Air Act to determine whether a standard to protect more than human health was "practicable." If the anticipated impacts were not offset or outweighed by the other concerns, then the standard was modified to prevent anticipated welfare effects.

Following completion of this process, a draft EIS was compiled and issued on January 3, 1979. The standards recommended in the draft EIS and the final EIS are shown in Table 1. Table 1 also shows the relationship of these proposed standards to existing state and federal standards.

The draft noted that there are in Montana approximately 50 "major sources" of air pollution, with a "major source" defined as a source emitting at least 100 tons of pollution per year. The draft was concerned primarily with the 13 sources that could potentially be affected by an ambient standard. These are: The Anaconda Aluminum plant at Columbia Falls, the Hoerner Waldorf pulp and paper mill in Missoula, the Anaconda Copper Smelter at Anaconda, the Stauffer Chemical Company phosphate plant at Ramsay, the Berkeley Pit copper mine in Butte, the ASARCO lead smelter in East Helena, the Cenex, Conoco and Exxon refineries in the Billings-Laurel area, the Montana Sulfur and Chemical Company plant in Billings, the Corette coal-fired generator in Billings, and the coal fired generators in Colstrip and Sidney. Figure 1 shows the sites of major pollution sources in Montana, and their relationship to existing and proposed Prevention of Significant Deterioration (PSD) Class I areas.

The most recent emission estimates from major sources are shown in Table 2. Ambient air pollution levels in the vicinity of these sources are shown in Table 3.

TABLE I , PROPOSED AND EXISTING AMBIENT AIR REGULATIONS

Pollutant	Federal Standard	Existing Montana Ambient Air Rule	Montana Ambient Standard Proposed in Draft EIS	Montana Ambient Standard Proposed in Final EIS
Sulfur Dioxide	0.03 ppm annual average 0.14 ppm 24-hour average not to be exceeded more than once a year 0.5 ppm 3-hour average not to be exceeded more than once a year	0.02 ppm maximum annual average 0.10 ppm 24-hr average not to be exceeded over 1% of the days in any 3-month period -- 0.25 ppm 1-hr average not to be exceeded for more than one hour in any 4 consecutive days	0.02 ppm annual average 0.10 ppm 24-hour average not to be exceeded more than once a year 0.40 ppm hourly average not to be exceeded more than once a year	0.02 ppm annual average 0.10 ppm 24-hour average not to be exceeded more than once a year -- 0.5 ppm 1-hr average not to be exceeded more than once a year
Total Suspended Particulate	75 micrograms per cubic meter, geometric annual average 260 ug/m^3, 24-hr average not to be exceeded more than once a year	75 ug/m^3 annual geometric mean 200 ug/m^3 not to be exceeded more than 1% of the days a year	75 ug/m^3 annual average 200 ug/m^3 24-hr average not to be exceeded more than once a year	75 ug/m^3 annual average 200 ug/m^3 24-hr average not to be exceeded more than once a year
Carbon Monoxide	35 ppm, 1-hr average not to be exceeded more than once a year 9 ppm, 8-hr average not to be exceeded more than once a year	-- --	9 ppm 8-hr average not to be exceeded more than once a year 17 ppm hourly average, not to be exceeded more than once a year	9 ppm 8-hr average not to be exceeded more than once a year 23 ppm hourly average, not to be exceeded more than once a year
Photochemical Oxidants (Ozone)	0.12 ppm hourly average not to be exceeded on more than one day a year	--	0.10 ppm hourly average, not to be exceeded more than once a year	0.10 hourly average, not to be exceeded more than once a year
Nitrogen Dioxide	0.05 ppm annual average --	-- --	0.05 ppm annual average 0.17 ppm hourly average, not to be exceeded more than once a year	0.05 annual average 0.30 ppm, hourly average, not to be exceeded more than once a year
Hydrogen Sulfide	--	0.03 ppm ½-hour average, not to be exceeded more than twice in any 5 consecutive days 0.05 ppm ½-hour average, not to be exceeded over twice a year	0.10 ppm hourly average, not to be exceeded more than once a year	0.05 ppm hourly average, not to be exceeded
Lead	1.5 ug/m^3, calendar quarter average	5.0 ug/m^3, 30-day average	1.5 ug/m^3 calendar quarter average	1.5 ug/m^3, 3-month average
Fluoride	--	1.0 ppb, 24-hr average, total fluoride (as HF) 0.3 micrograms per square centimeter per 28 days (gaseous)	1.0 ppb 24-hr average 0.30 ppb 30-day average 0.13 ppb growing season average	1.0 ppb 24-hr average, gaseous fluoride 0.3 ppb 30-day average
Foliar Fluoride	--	35 ppm, dry weight basis	30 ug/g, dry weight basis	35 ug/g in forage, annual average, no monthly average to exceed 50 ug/g
Settled Particulate (Dustfall)	--	15 tons/sq mile/month, 3 month average in residential areas 30 tons/sq mile/month 3 month average in heavy industrial areas	10 gm/m^2 30 day average	10 gm/m^2, 30-day average
Visibility	--	--	Particle scattering coefficient of 2 X 10^{-5} per meter annual average	Particle scattering coefficient of 3 X 10^{-5} per meter annual average
Reactive Sulfur (sulfation)	--	0.25 milligrams sulfur trioxide/100 sq. centimeter/day, maximum annual average 0.50 milligrams sulfur trioxide/100 sq. centimeters/day, max. for any 1-month period	--	
Suspended Sulfate	--	4 ug/m^3 of air, max. allowable annual avg. 12 ug/m^3 of air, not to be exceeded more than 1% of the time	--	--
Sulfuric Acid Mist	--	4 ug/m^3 of air, max. allowable annual average 12 ug/m^3 of air, not to be exceeded more than 1% of time 30 ug/m^3 of air, hourly average, not to be exceeded over 1% of the time	--	--
Beryllium	--	0.01 ug/m^3, 30-day average	--	--
Arsenic	--	--	--	Deferred for further study
Cadmium	--	--	--	Deferred for further study

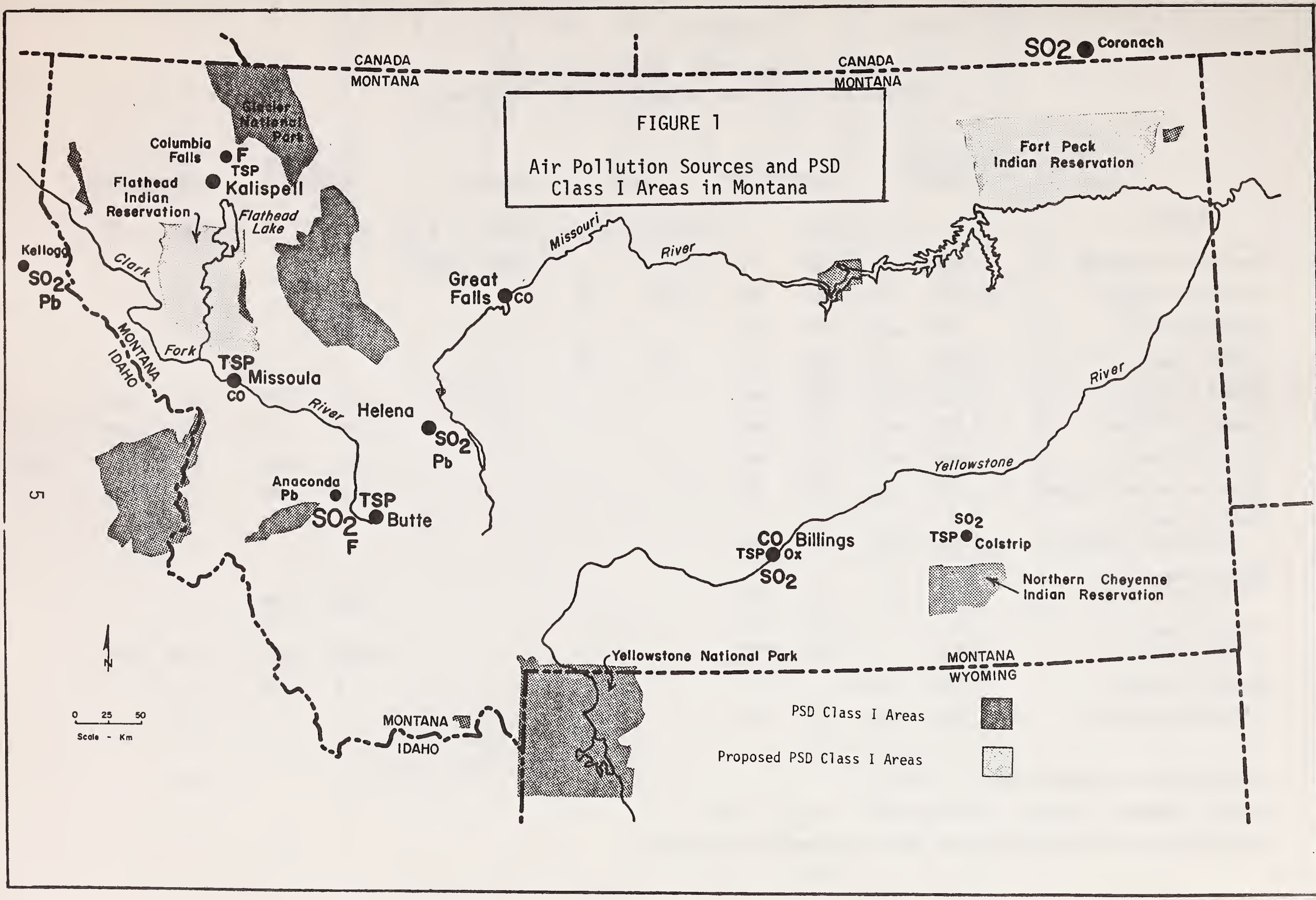

FIGURE 1

Air Pollution Sources and PSD Class I Areas in Montana

TABLE 2

ESTIMATED EMISSIONS FROM POINT SOURCES
OF AIR POLLUTION AND PRESENT DEGREE OF CONTROL

	SULFUR DIOXIDE		PARTICULATE		LEAD		FLUORIDE		NITROGEN OXIDES		HYDROCARBONS	
SOURCE	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%
Anaconda Aluminum	2,200	0	1440	77			455	90				
Anaconda Copper	281,750	34	4780	95	179	95						
Berkeley Pit	207	unk	4023	33								
ASARCO Lead	14,000	76	418	96	48	95						
CENEX Refinery	10,380	unk	398	unk					540	unk	1317	unk
Conoco Refinery	3,198	unk	263	unk					1,194	unk	1991	unk
Exxon Refinery	9,800	unk	735	unk					1,401	unk	4177	unk
Hoerner Waldorf Paper	365	unk	760	98					1,008	unk	115	unk
Montana-Dakota Utilities, Sidney	2,372	15	430	98								
Mont. Power Co. (Colstrip 1 & 2)	5,326	75	618	99					7,000	unk		
Mont. Power Co. (Corette)	9,986	10	1124	97					6,757	unk	94	unk
Montana Sulphur	1,530	97							4	unk		
Stauffer Chemical	208	unk	99	96			35*	90				

unk=unknown or unmeasurable

Source: Gelhaus, et al., 1978; Constant et al., 1977

*Anticipated emissions based on emission control projection.

TABLE 3

SUMMARY OF SELECTED AMBIENT AIR QUALITY DATA (1978)

Pollutant and Averaging Time	Missoula	Anaconda	East Helena	Great Falls	Billings	Colstrip
Sulfur Dioxide	Lions Park	Lincoln School	East Stack	--	Central Park	--
Max. 1-hr. (ppm)	0.05	1.21	0.48		0.195	
Max. 24-hr. (ppm)	0.02	0.37	0.10		0.091	
Annual Average (ppm)	0.00	0.02	0.004		0.010	
	(10 months)	(7 months)	(11 months)		(7 months)	
Particulates	Courthouse Roof	Highway Junction	Microwave	Fire Station	City Hall	BN
Max. 24-hr. (ug/m^3)	389.7	155.0	101.0	125.0	175.0	138.0
Annual Geom. Mean	64.0	26.9	23.4	55.4	64.8	13.0
	(12 months)	(12 months)	(12 months)	(12 months)	(11 months)	(4 months)
Settled Particulate (gm/m^2) monthly mean	--	--	--	Fire Station	--	--
				4.52		
				(9 months)		
Visibility	Lions Park	---	---	---	---	---
Annual Avg. (miles)	17					
	(12 months)					
Carbon Monoxide	Mal. Junction	---	---	10th Ave. S.	27th & Mont.	--
Max. 1-hr. (ppm)	28.0			15.1	15.9	
Max. 8-hr. (ppm)	15.0			11.5	8.4	
	(5 months)			(10 months)	(6 months)	
Ozone	Lions Park	*	---	---	27th & Mont.	*
Max. 1-hr. (ppm)	0.078				0.120	
	(12 months)				(7 months)	
Nitrogen Dioxide	Lions Park	Lincoln School	---	---	Central Park	---
Max. 1-hr. (ppm)	0.098	0.050			0.075	
Annual Arith. Mean	0.016	0.006			0.012	
	(10 months)	(3 months)			(4 months)	
Total Hydrocarbons	Lions Park	---	---	---	27th & Mont.	---
Max. 1-hr. (ppm)	8.13				11.40	
	(11 months)				(5 months)	

*=no data

---=less than 3 months data

AIR QUALITY TRENDS IN MONTANA

Billings

The sulfur dioxide levels in Billings have remained generally the same over the past three years with an annual average of about .003 ppm in residential and traffic areas. The sulfur dioxide levels near the Cenex refinery in Laurel seem to have decreased from 1976 to 1978. The 1979 data, although incomplete, appear to be about the same as the 1978 data. No clear trends emerge from the total suspended particulate data. The data from 1975 through 1978 appear relatively constant at most sites. The 1979 data analyzed so far may be a little higher.

The ozone and carbon monoxide data from Billings follow the same general trend as total suspended particulate. These pollutants were monitored at different locations throughout the past four years, making an analysis of the trend difficult.

It would appear that the readings from the Billings stations have not changed significantly, with a few exceptions, over the past four years. The emissions from industrial sources of pollution have generally remained constant, while the population base has been increasing. A slight increase in the total suspended particulate number for 1979 may be due to a combination of meteorological conditions and population expansion.

Anaconda

The air monitoring work done in the Anaconda area has generally been limited to sulfur dioxide and total suspended particulate. In general, the sulfur dioxide readings have been increasing since 1975 from about .014 (annual average) to .056 in 1978. The data are not complete enough for 1979 to yield a valid annual average. The change shown is unusual since the

Anaconda Company has significantly reduced its emissions ince 1975. The reason for the increasing readings is due to the decreased bouyancy of the emissions as they are released into the atmosphere. This decreased disperssion has been caused by the installation of controls required by the State. Although the concentration of sulfur dioxide in the main stack plume is less than in the past, the plume is more inclined to reach the ground sooner. The total suspended particulate readings for the area have remained relatively unchanged since 1976 (approximately 40 ug/m^3) annual average. The 1978 values were lower than all other years for unknown reasons. It appears that 1979 was a typical year for total suspended particulate in Anaconda.

Butte

Butte has been monitored for total suspended particulate for many years. The readings have decreased from 1976 through 1978. However, the readings increased by about 10 percent in the first 10 months of 1979. Nitrogen dioxide, ozone, sulfur dioxide, and carbon monoxide have all been measured in Butte for the past year. Although the data is preliminary at this point, it appears that nitrogen dioxide, carbon monoxide, and ozone may be present, but not in sufficient quantities to exceed the proposed standards. The data on sulfur dioxide are too preliminary to define the concentrations present.

Columbia Falls

The Columbia Falls area has had a relatively constant level of total suspended particulat over the past four years. The data show levels in excess of the proposed standard. The area has already been determined to be in violation of federal standards. It is suspected that road traffic and conditions are the major cause of these readings. A sampler located

near the Anaconda Aluminum Reduction Works show much lower readings than the sampler in town.

Great Falls

Great Falls has been the subject for monitoring of carbon monoxide and total suspended particulate. The total suspended particulate readings in the downtown area of Great Falls decreased from 74 ug/m^3 (annual average) in 1976 to about 56 ug/m^3 in 1978. The 1979 data, however, show an increase to 77 ug/m^3. The cause of this change is unknown. A carbon monoxide monitor on 10th Avenue South has been in operation for about two years. The data from this site show about 14 violations of the federal eight-hour standard for carbon monoxide.

Missoula

Total suspended particulate measurements have been taken in Missoula for many years. Since 1976 the readings have generally remained constant. However, inclusion of 1979 data, may show a downward trend. The 1976 average reading was 86 ug/m^3 while the 1979 average of data thus far analyzed was approximately 79 ug/m^3. There have been a number of emission controls initiated at various facilities in Missoula since 1976. Population gains and/or meteorological conditions may have offset some of these controls.

East Helena

The East Helena area has been studied for sulfur dioxide, total suspended particulate and lead. The sulfur dioxide levels have generally decreased starting in 1978. The reason for the decrease is believe to be the emission control systems implemented about the same time. The annual geometric mean for the past four years is 77 ug/m^3, except 1977 when the mean was 64 ug/m^3. This indicates violations of the 75 ug/m^3 national and proposed state standards.

The cause of the lower 1977 reading is unknown. Lead also has been measured at this site for the last two years. The data show exceedance of the proposed state and existing federal lead standard.

AIR POLLUTION IN MONTANA

The draft EIS pointed out that there is reason for concern about the extent and seriousness of air pollution in Montana. Although there are relatively few sources of industrial pollution, the areas affected generally are the population centers of the state. Furthermore, the measured levels of several pollutants are higher than those which have been scientifically established to cause health effects in humans. The pollutants reaching these excessive levels in Montana are sulfur dioxide, particulates, lead, carbon monoxide, nitrogen dioxide and ozone. There are no completed studies to show whether these effects are occurring in Montana, but there is no reason to believe that people in Montana would be more or less endangered by a given pollutant level than residents of other areas. It was said in the draft EIS that hydrogen sulfide was a threat to health at levels found in Montana, but further review of the data led to the recommendation of a standard based on welfare effects.

Besides human health effects, many of the pollutants found in Montana can affect plants and animals, materials, and other elements important to human "welfare." Two pollutants, hydrogen fluoride and hydrogen sulfide, affect plants and animals at levels more dilute than those necessary to threaten human health, so the standards recommended to the Board in the final EIS are based exclusively on these "welfare effects." The recommended standards for each pollutant are expected to protect both human health and the environment. Mobile and area sources, such as automobiles, strip mines, and

dusty roads, also can be significant emission sources, but emissions from these are not generally as significant as those from industrial point sources.

The issuance of the draft EIS was followed by a massive outpouring of comments from industry and other concerned groups and individuals. In response to these comments, there was much reanalysis of data, review of a few research results not previously reviewed, and other efforts to clarify and update the findings and conclusions of the draft. As a result, there were some changes made in the recommended standards. These changes are apparent in Table I.

The proposal in the draft EIS to make the standards directly enforceable generated a considerable volume of comments, all of which were reviewed and evaluated in determining the Departments final recommendation on an enforcement stance.

The following are the principal enforcement recommendations of the Department's final proposal:

- Change the ambient air quality standards from their current form to expressly enforceable standards (no change from draft EIS);
- Adopt the standards without limitation of enforcement measures (no change from draft EIS);
- Limit the definition of "ambient air" to include only areas where the general public has access (change from the draft EIS).

A major need pointed out in the comments on the draft EIS regarded the need for an analysis of the alternatives available to the Department. The Final EIS states the Department's position that there are no legal alternatives to the standards recommended to protect health, in view of the Clean Air Act's requirement that health be protected, and the scientific evidence and analysis

indicating that the standards recommended are necessary to fulfill that requirement.

There also were many comments to the effect that alternative modes of enforcement should have been analyzed in the draft EIS. The final EIS discusses the limitations of these suggested alternatives, and points out why they are not available for adoption.

Many comments asserted that draft EIS did not contain adequate information regarding the impacts of the Department's proposal. The discussion of impacts in the draft was concerned primarily with the effects of various levels of pollution on human health and welfare. These findings are organized and supplemented in the final EIS with an analysis of the probable impacts of the Department's proposal.

ANTICIPATED IMPACTS OF THE DEPARTMENT'S PROPOSAL

The impacts of the proposed ambient air quality standards would occur in two broad areas: (1) a reduction in the effects of air pollution upon humans and the natural environment, and (2) economic and environmental costs necessary to achieve the air quality standards.

There are two fundamental constraints upon the Department's ability to predict the exact impacts of its proposed ambient rule. The first is the important role played by the existing regulatory background. Particularly with respect to new sources, current regulatory programs would largely determine the abatement requirements which would be applied to pollution sources.

Secondly, as noted previously, it is difficult to quantify the impacts of the proposed standards either as cost (additional control of emissions) or benefits (reduced effects on humans, plants, animals and the environment.)

For this reason, the discussion on anticipated impacts is largely cast in qualitative terms rather than quantitative.

It can be said, for example, that standards based upon health considerations would reduce the potential for human health effects. Lower potential for disease, fewer sick days, and the reduced potential for interference with normal human activities may be expected to increase the productivity of the state's people.

Farming and ranching, wood products and recreation, which account for more than one-half of the state's economic activity, all depend upon clean air. The proposed standard could contribute to preserving the productivity of these sectors.

Furthermore, much of the state's residential growth can be attributed to the natural amenities available in Montana, including its unpolluted air. The proposed standards, particularly those for the urban pollutants, visibility, and settled particulate should preserve these amenities and Montana's attractiveness as a place to live.

In an attempt to quantify the economic aspects of air pollution in Montana, the Department contracted the production of a study (Otis et al., 1979) to define the situation. This study estimates the change in death rates that could be anticipated in Helena, Anaconda, and Billings if sulfur dioxide emissions were reduced to meet the existing federal and state ambient air quality standards. Using two procedures for calculating the health effects and two values for the reduction in risk to life and health, estimates of social economic benefit were obtained for moving from present ambient levels to the federal standard ($1 million to $4 million per year) and moving from present ambient levels to the proposed state standard ($1 million to $7 million per year). Estimates for the loss of agricultural crops and ornamental plants in four

Montana counties were calculated. The crops included alfalfa, wheat, and timber. The estimated economic benefits were approximately $800 thousand per year for meeting the federal standard and approximately $1 million per year if the state standard were met. The reduction in damage to materials, primarily galvanized zinc surfaces and paints, was estimated to be approximately $100 thousand per year for meeting either state or federal standards. Finally, estimates were made for the loss of visibility from particulate matter derived from sulfur dioxide in the Billings area. Depending on the choice of assumptions regarding who "owns" clean air, the annual value of improved visibility is calculated to be between $100 thousand and $1 million for achieving the federal standard and $200 thousand to $2 million for achieving the state standard.

The costs of reducing emissions to meet the federal and state standards were estimated for the seven largest sources of sulfur dioxide in Montana. At Anaconda Copper a $21 million acid plant already scheduled for installation to meet federal standards is expected to reduce emissions sufficiently to achieve both the federal and state standards. The CENEX petroleum refinery in Billings already is planning to spend about $5 million to meet the federal standards. An additional $1 million might have to be spent to meet the state standard. The controls needed by Montana Power's Corette plant to meet the state standard could cost between $7 million and $11 million, depending on the engineering difficulty. The Exxon refinery might have to spend about $9 million on controls to meet the state standard. No additional control is likely to be required at either the Corette power plant or the Exxon refinery to meet the federal standards. The Conoco refinery does not appear to require any additional controls to meet either standard. Montana Sulfur already had agreed to install a new stack for less than $1 million that may permit the plant to meet both standards. The ASARCO lead smelter in East Helena recently

installed control equipment that may enable it to meet both standards. Approximately $40 million was spent on the control program.

When control costs are compared to the estimated benefits of control, it is found that for both the high and low estimates, the additional costs of moving from the federal to the more stringent state standard is roughly equal to the additional benefits. This is the best measure of economic efficiency and it suggests that the proposed state standard is economically optimal for Montana.

The final EIS also discusses the economic aspects of the proposed fluoride standards in relation to the state's two major sources of fluoride emissions, the Anaconda Aluminum plant and the Stauffer Chemical phosphorus plant. Estimates are reported for damage from fluorides in the Columbia Falls and Ramsay areas. Both facilities are completing installation of new control equipment. The control programs at both plants are expected to achieve the proposed fluoride standards. In both instances the analysis indicates that the present control programs are economically justified but further indicate that new control programs would not be economically justified on the basis of currently available economic and engineering information.

II. COMMENTS ON THE DRAFT EIS

INTRODUCTION

Approximately 1400 pages of comments were received in response to the draft EIS. All these comments were carefully read and evaluated. Following this review, it was decided that the best way to respond to these comments was to consolidate and summarize them to eliminate redundancy and irrelevance.

In most cases the comments were paraphrased, and where two or more commentators made similar points, they were merged into one comment. Thus, although a comment may not appear here in exactly the same form it was made, the substance of the comment should be found in this chapter, along with a response to the issues it raised. The review was limited to comments relevant to the decision making process. Comments presenting data, pointing out research that had been overlooked, or otherwise suggesting refinement of the document were responded to. These comments led to many alterations in the various conclusions made in the draft EIS. Their ultimate effect may be seen in the changes made in the recommended standards, as summarized in Table 1. Comments which merely stated an unsupported opinion were noted but not responded to in most cases. Such comments are of little use in evaluating the scientific bases for ambient air quality standards.

Approximately 300 copies of the draft EIS were mailed out to industry, environmental groups, state, federal and local government organizations, and individuals. The parties responding with comments are shown on the following page.

RESPONDENTS TO THE DRAFT EIS

AGRICULTURE, Montana Department of
ANACKER, Robert
ANACONDA CO.
ANACONDA ALUMINUM
ARNO, Steven
ASARCO
AUSTIN, Briggs
BISSELL, Gael
BOHRER, Kathleen
BROMENSHENK, Jerry
CENEX
CHAMPION INTERNATIONAL
CONOCO
DIXON, Mattie
DRIEAR, Ralph
EASTER, Charlotte
ECOLOGICAL CONSULTING SERVICE, Inc.
ENGBRETSON, L. N.
ENVIRONMENTAL INFORMATION CENTER
ENVIRONMENTAL STUDIES graduate students of the University of Montana
ERICKSON, Ron
EXXON
GOOSSENS, Elizabeth
GORDON, Clarence
HIGHWAYS, Montana Department of
HILL, Clyde
HURLBERT, Ardelle (League of Women Voters)
INTERIOR, U.S. Department of
JOHNS, Carrie
LEAGUE OF WOMEN VOTERS
LEAR, Jill
LIVINGSTON, Steve
MAGNUSON, William
McCONNELL, Wenona
McKELVEY, Mavis
MILLER, Margueritte
MILES, Joan
MISSOULA Vo-Tech
MONTANA POWER
MONTANA SULPHUR AND CHEMICAL COMPANY
MOORE, William
MUTH, Bob
MYREN, Ben
NORTHERN PLAINS RESOURCE COUNCIL
O'LOUGHLIN, Jennifer
OVERCAST, Beverly
PHILLIPS PETROLEUM
RICE, Pete
SARGENT, Leonard
SCHWARTZMAN, Steven and Tina
STAUFFER CHEMICAL
STEFFEL, Richard
STONE, Florence
TOURANGEAU, Phil
WESTMORELAND RESOURCES, Inc.
ZACKHEIM, Karen

C.* The principal effect of imposing directly enforceable standards will not be an environmental improvement but rather an elaborate air quality monitoring network costing more than $3,500,000, far more than the public will benefit from any improvement in air quality.

R.** Such contentions are unfounded. The Bureau operated for years in the belief that the old standards were enforceable without the major monitoring effort suggested in the comment. The Bureau recently completed a network review of all monitoring stations in the state. Based on this review, the Bureau currently is making the necessary changes to establish a comprehensive and cost-effective monitoring network. It is true, however, that there probably would be times when a more extensive network was necessary to deal with special problems such as multiple sources. In multiple source areas, the Bureau might have to initiate special studies to determine what portion of the ambient pollutant concentration came from each source. While some increases in staff and equipment may be necessary, the costs of such studies can be partially offset by strategic deployment of existing monitoring resources.

It must also be pointed out that such studies would be necessary even if ambient standards were enforceable only through emission standards. Similar information would be required to determine which sources would require emission reductions to bring ambient concentrations to an acceptable level.

C. A diligent monitoring program is essential for the enforcement of the proposed ambient standards. Too often in the past, inadequate monitoring data has made it impossible to enforce standards.

R. In some cases, enforcement of air standards has been hampered by inadequate monitoring data. Implementation of changes suggested in the recently completed monitoring network review should largely remedy such inadequacies.

C. Additional data are needed on air pollution levels in Billings and their effect on lung function.

R. Such data would be helpful, but in their absence, information from other places can be relied upon for general applicability. In an attempt to develop data pertaining to the Billings situation, the Montana Air Pollution Study asked permission to test lung function of public school children for comparison with pollution levels but was turned down by the school board. Subsequently MAPS arranged to test school children in the Billings Heights area, and data from this testing will be forthcoming.

*C = comment
**R = Response

C. Open mining operations are incorrectly described as a point source. They should be discussed as an area source.

R. One common criterion in differentiating between these two types of pollution sources is the size of the individual source. A point source is a significant source of pollution by itself. Area sources such as a fleet of personal automobiles or a substantial number of home heating furnaces, comprise many small sources which collectively contribute substantial emissions. It is simply a matter of the scale of the source with respect to other sources. An open pit mine, for example, may have no distinct point of emission but it is usually the only particulate pollution source in the vicinity.

C. In the working papers, the Department pledged to consider long-term productivity of the environment. Such consideration is conspicuous by its absence in the draft EIS.

R. Some discussion of these problems is included in the draft EIS at pp. 97-101 and pp. 173-175. Very little information is available because very few experiments have been done.

C. It is somewhat illogical to reject the federal ambient standards because they were developed to regulate pollution in heavily industrialized large cities and then use information from studies done in these same heavily industrialized large cities to develop standards for the "unique" Montana situation.

R. A major impetus of the Montana Clean Air Act was the desire to keep the air in Montana from resembling that in industrialized urban areas. Also, although the studies performed elsewhere might not be as completely convincing as they would be if performed in Montana, they nevertheless are the only ones available in many cases. Although many of the conditions relating to the impacts and potential impacts of air pollution in Montana are unique, the people and plants in Montana have much the same reaction to air pollution as their counterparts elsewhere.

C. The Department said that one of the primary purposes was to update the air quality standards based on newly published data. Yet many of the studies cited by the EIS were included in the original EPA criteria documents. How could MAAQS have reviewed the same literature and come to the conclusion that a more stringent standard was needed?

R. The draft EIS represents a substantial update on the 1970 EPA criteria documents. Over 38 percent of the papers cited in Chapter 3 of the draft EIS were published in 1975 or later and another 31 percent of the papers were published between 1971 and 1975. Some of the papers cited appeared in the EPA criteria documents and many of these remain the best available

studies in their respective areas. In some cases (e.g., the annual standard for nitrogen dioxide) the data base is essentially the same and the standard proposed is the same. In other cases (e.g., the annual standard for sulfur dioxide) the data base is unchanged but the standard recommended by MAAQS is more stringent. In general this change is based not on any new interpretation of these papers but on different evaluation of the desirable margin of safety. In other instances, the data base has changed radically (e.g., the carbon monoxide standard) as new studies have more clearly revealed the level at which adverse effects occur.

C. Economic discussions of the costs and benefits of controlling air pollution create a distortion in priorities. The economic arguments posed against enforceable standards by industry are important, but so are the health, welfare and future of Montana.

R. Comment noted.

C. The standards recommended in the EIS show that the public welfare has again been made subservient to corporate profit.

R. Comment noted.

C. There should be no loosening of the former ambient air quality standards, especially not for hydrogen sulfide.

R. The response of commentators to the proposed loosening of the hydrogen sulfide standard led the bureau to re-evaluate its position. The tighter hydrogen sulfide standard now recommended is explained in the conclusions portion of this EIS.

C. In numerous instances the draft EIS quotes out of context, misquotes cited references, or fails to state qualifications to data implicit in the cited papers.

R. The Department attempted to avoid such errors. Copies of preliminary drafts were issued as "working papers" and distributed to everyone thought to be interested. The draft EIS was circulated for comment. Both the working papers and the draft EIS were submitted to a panel of achknowledged national experts for their review and comment. Specific errors pointed out in this review process are discussed throughout the Comment and Response Chapter of the final EIS.

C. Many studies commonly included in a review of the literature such as this are not included in the draft EIS. The studies that are used often are not reviewed critically.

R. Most of the studies that were not included were found to have some serious fault (e.g. based on sulfation plate readings). Although there were minor problems with almost every study examined, the criticisms commonly advanced against those included often seemed to be more in the nature of academic pedantry than useful analysis. If criticisms were fatal, the study (or that part of the study) was not included. If the criticisms were less serious, the problems were generally mentioned as a qualifier or if they were insignificant, they were not mentioned, to avoid producing an unreadable catalog of minutae.

C. Results from the Montana Air Pollution Study (MAPS) should be given more attention.

R. Conclusive results are not expected from MAPS before these standards are to be considered by the Board of Health.

C. Montana's economy needs clean air. Agriculture, a billion dollar industry in Montana, is the chief economic sector in the state. Tourism is second and timber production is fourth. Agriculture and timber production alone provide 55 percent of the primary employment in the state. Yet it is the agricultural sector of Montana's economy which is most directly threatened by air pollution.

R. The Bureau's concern with the effects of air pollution on agriculture are reflected in the setting of standards considered sufficient to protect vegetation.

C. The Montana Department of Agriculture supports the proposed ambient air quality standards and considers them the minimum acceptable.

R. Comment noted.

C. The draft EIS doesn't adequately discuss the effects of air pollutants on aquatic plants and animals.

R. The primary effect of air pollutants on water bodies is through increasing acid content. This is discussed on pp. 97-98 of the draft. It is not possible to discuss every possible effect from every potential pollutant.

C. You have not documented how the federal standards are insufficient to meet the statutory mandate of the Montana Clean Air Act.

R. No attempt was made to compare the proposed Montana standards to federal standards. The mandate of the Montana Clean Air Act was followed. If

the logic of the analysis led to the same value selected by the federal government then this value was recommended. If not, the proposed standard was different.

C. Montana should at least wait until EPA completes its full review mandated by the 1977 amendments (EPA must promulgate new SO_2 standards by the end of 1980).

R. In the 1977 Clean Air Act Amendments, Congress directed the EPA to conduct a review of each current standard by 1980. The review of the photochemical oxidants standard has been completed. The review of the carbon monoxide standard is nearing completion, but is far behind schedule. The reviews of the annual standards for nitrogen dioxide, sulfur oxides and for particulate have barely started and realistically cannot be expected to be completed until 1982. When completed, these reviews will be evaluated for their applicability to Montana conditions.

C. The federal requirements for visibility protection are only now being implemented and do not require any specific action by the state of Montana at this time. The proposed standards are premature.

R. The proposed Montana standards are not being proposed in response to the federal law but in response to the mandate of the Montana Clean Air Act.

C. The draft EIS does not put air pollution in its proper context. It is much less harmful than cigarette smoking.

R. It is well known that cigarette smoking is a dangerous form of self pollution. Nevertheless, it is voluntarily undertaken by the victim. Those who object to smoking in their presence are gaining new legal affirmation of their rights to be free of such smoke.

Large scale air pollution, by contrast, covers large areas and affects millions of people who live in the polluted areas. Such pollution also affects children, who have no choice in where they live. Furthermore, air pollution is known in some cases to act more severely on persons who smoke. It is a fallacy to suggest that since one kind of poison may be worse than another, the lesser of the two should be ignored.

C. The Air Quality Bureau refused to provide copies of the unpublished papers Carlson (1978), Krook and Maylin (1978) and Miles (1978).

R. Copies of all these papers were available in the Air Quality Bureau office. Carlson (1978) is protected by copyright (Title 17, U.S. Code) and could not be reproduced by the Department. A copy of this paper is also available at the University of Montana library. No request was received for Krook and Maylin (1978) which was published in a scholarly journal available to the public nor for Miles (1978) which earlier had been given to the commentator by Miles.

C. Epidemiological studies regarding various pollutants are irrelevant and misleading since none of these studies was performed under the meteorological conditions found in Montana.

R. The manner in which a plume disperses or the amount of rain in July has no substantial relationship to the reaction of a human being to a given concentration of pollutant in the air. The residents of Montana could be expected to react in much the same way as the subjects of these studies if they were exposed to the same concentrations of pollutant for a similar time. The ambient air standards are designed to insure that such exposures do not occur.

C. Unsupported literary allusions and generalizations (pp. i-viii) have no place in an EIS; for example, comments that air pollution causes death.

R. This is a question of style in trying to write a document readable by a broad audience. Introductory remarks were stated generally and without citation. In each instance, detailed information on the topic in question was presented in the appropriate portion of the EIS.

C. The EIS says (p. 10) that effects on humans, including "visible tissue damage or even death" may occur "at commonly occurring ambient air pollution levels." However, the EIS provides no evidence whatever that any such effects may be or have been attributed to acute exposure to ambient levels found in Montana. If there is no such information, then such emotional and groundless statements should be eliminated.

R. The phrases referred to should have been composed more carefully. The comment, by quoting out of context and sequence, does not add to understanding. Numerous studies cited in the draft EIS describe immediately visible effects such as tissue irritation or inflammation and other studies cited associate increased death rates with higher pollution levels. Many of these studies were conducted under conditions similar to those that may be found at various locations in Montana. Only a limited number of studies of health effects of air pollutants have been carried out in Montana but they have often observed the same effects seen elsewhere. For example, a study of residents living in Butte and Anaconda reported an abnormally high rate of lung cancer (Newman, et al., 1975).

C. The statement (p. iii) that the proposed standards would protect human health and to a major extent the environment is a glib misrepresentation inconsistent with statements made in the conclusions chapter.

R. The proposed standards are intended to protect the human health of Montana residents with a reasonable amount of certainty. The standards are in accordance with the mandate established by the Clean Air Act of Montana (Title 75, Chapter 2 M.C.A.) to protect health. The majority of Montana's environment also will be protected. However it is clear that certain highly sensitive components of the environment may incur some adverse impacts.

Such damage would be likely for some sensitive plant species at any pollutant level under certain conditions.

C. The increments available (pp. 6-7) under PSD rules will be consumed by simulation modeling of new sources using worst case meteorology, not by using ambient monitoring data of normal or average conditions.

R. Reductions in the available increments would be made by simulation models which could be corrected with actual monitoring data. However, if monitoring data were used, the worst case values (actually second highest concentrations) would be used for 24-hour or 3-hour time periods. For annual periods, the annual average concentration predicted by the model would be used.

C. The baseline under the PSD regulations (pp. 6-7) is not 1974, but rather August 7, 1975, with changes made to baseline based on sources approved for construction prior to January 6, 1975 and not yet constructed as of August 7, 1977. Other changes also can be made to the baseline. The future of the PSD regulations are clouded by a recent adverse court decision.

R. The recent D.C. Circuit case of <u>Alabama Power Co. v. Costle</u> has declared that the PSD baseline for an area is the pollutant level existing on the date of the first application for a PSD permit in that area. The final form in which the federal PSD regulation will be promulgated is not yet known.

C. The statement (p. iv) that "sulfur dioxide at concentrations known to occur in Montana has been demonstrated elsewhere to contribute to increased death rates, irritation of the throat and lungs, and injury to throat and lung tissues" is loose and not supported by citations.

R. The situation regarding the health effects of sulfur dioxide in Montana are accurately reported on page 49 of the Draft EIS, where it says:

> *Sulfur dioxide and particulates at the concentrations occasionally recorded in Montana have been observed to have adverse effects on human health. Sulfur oxides irritate the throat and lungs and contribute to increased respiratory disease. The health effects of sulfur dioxide are more pronounced in the presence of a moderate amount of fine particulate. The persons most sensitive to sulfur oxides and particulate exposures are those with asthma, children and elderly bronchitis patients.*

C. Fluoride should be included in the list of feasible standards on p. ii.

R. Correct.

C. The draft EIS fails (p. ii) to say that the old standards for gaseous fluorides (0.3 micrograms/cm^2/28 days) and fluorides, total (as HF) in air were deleted.

R. Correct. They are recommended for deletion.

C. It is reasonable to ignore pollution induced effects such as reversible changes in body function, especially where such variation falls within the normal range and does not predispose the individual to disease, disability, or reduced life expectation. Excessive concern with (p. 9) such reversible physiological changes ignores the magnificent ability of biological systems to adjust to and compensate for stress. It is through stress that evolution occurs and people and societies grow strong.

R. The normal variation among individuals covers an extremely wide range. In some cases for example, the level of a normal function for a small woman might be only 75 percent of the same function for a large man, although both were "normal." So-called reversible changes need to be dealt with carefully, although they are rightly of less concern than changes known to be universally irreversible.

C. It is unrealistic to attempt (p. 9) to protect people who are hypersensitive to some pollutants. It is just too expensive. It is not clear that the Air Quality Bureau adequately took into account the effects on sensitive groups in setting the standard.

R. In making its recommendations for air quality standards, the Department paid special attention to studies that involved sensitive individuals, such as persons with bronchial asthma, emphysema, or chronic obstructive lung disease. In general the effects on hypersensitive individuals, persons who might almost be said to be allergic to the pollutant, were not considered, in part because there are very few studies that can provide statistically reliable data on the effects and in part because these individuals would be a very small portion of the population. The groups considered in setting each standard are detailed in the conclusions chapter of this final EIS.

C. It is inappropriate (p. 11) to use clinical exposure to a single pollutant at an unchanging concentration for extended periods of time (10 minutes to several years) to establish a standard since this would not be expected to occur under natural conditions.

R. Depending on a number of factors, such as the type of source, the local topography and meteorology, and the relative location of the source and receptors, the exposure pattern may be rather constant, varying over a relatively narrow range, or may be marked by extreme fluctuations from almost no pollution to brief, very high concentrations. Both extremes and many situations between the two are observed at different sites around

Montana. This is part of the reason both long and short-term standards are proposed. Most laboratory studies use single, constant exposure concentrations, in some cases up to two years in duration. The comment is correct that it is not at all clear how this relates to the experiences of people in varying ambient environments. Although it is desirable to base the standard on animal, clinical and epidemiological studies for just these reasons, conclusive epidemiological studies often do not exist (a good epidemiological study is very expensive to conduct). In the absence of epidemiological studies animal and clinical studies may be heavily relied on. It is entirely uncertain if the long-term, constant exposure will understate or overstate the effects the same subjects would experience in a natural environment with an equivalent annual average exposure.

C. The EIS is incorrect in saying (p. 11) that laboratory studies underestimate the effects of pollution on the general population, since, for example, many people in the general population may adapt to ambient sulfur dioxide concentrations with no ill effects, and thus may not respond to sulfur dioxide levels sufficient to cause various effects in laboratory experimental subjects not accustomed to the pollutant.

Furthermore, it must be remembered that people in the general population, and especially those particularly susceptible to air pollution, spend much of their time indoors, away from the outdoor ambient levels. Therefore, the responses seen in laboratory studies with given levels of sulfur dioxide probably actually overstate the effects that would occur at a corresponding outdoor ambient concentration of sulfur dioxide.

Also, many of the responses seen in the laboratory are not adverse.

R. Although some people do spend substantial time indoors, it does not necessarily follow that they are totally protected from air pollution. Indoor levels of pollutants, although generally lower, tend to increase as outdoor levels increase. Moreover, it would be entirely improper to assert they should stay inside to avoid adverse effects from air pollution. Nor is it clear that adaptive responses are "cost-free" to human health. It would be scientifically irresponsible to assume that the general public has adapted but that laboratory subjects have not. There may be some such cases but they would not likely be the norm. Whether a particular effect measured in a laboratory experiment is adverse must be determined on a case-by-case basis. Laboratory studies often permit the measurement of very subtle changes that some people may be less inclined to label as adverse.

C. The relative applicability of animal studies, clinical studies and epidemiological studies is not made clear (p. 11).

R. In general, animal studies were reviewed only to define mechanisms of effect, although they may be considered as the basis for standards if there are no clinical studies on human subjects. If animal studies are used to establish standards a larger margin of safety should be used. Epidemiological studies of sensitive groups in the population are preferred as the basis for standards, but when they were not available results from controlled exposure clinical studies were used. When these studies are

used, the character and health of the studied population is important. If it is healthy, young men (as is commonly the case) then a substantial margin of safety is called for to protect less healthy people.

C. It is necessary to be very careful in using epidemiological studies of general populations (p. 11). The actual exposures to pollutants are poorly known and other causes of poor health (e.g. cigarette smoking, influenza epidemics, heat waves, etc.) frequently are not controlled for. At best, such studies can only establish a correlation between the pollutant and the effect. Such correlation does not imply causation. Causation must be confirmed by laboratory experimentation on animal or, preferably, human subjects.

R. Biologic causality can be very difficult to establish. Many people still argue that it is not proven that cigarette smoking causes emphysema or cancer. Often the best that can be hoped for is evidence of a similarity between the laboratory observed effect and the disease conditions observed in the field. Yet there is little doubt that pollution contributes to or aggravates disease. Since air pollution control is intended to be preventive, action often is needed before conclusive proof is available.

C. The statement (p.15) that the margin of safety for a pollutant depends on the difficulty of controlling the source is contrary to other statements in the EIS, and the legal requirement that the public health be protected.

R. Correct. The sentence should have read, "The margin of safety for any given pollutant depends primarily on the seriousness of the danger from that pollutant and on the certainty with which the effects are understood."

C. The federal air quality standards were required to be set to protect the public health with an adequate margin of safety. Thus EPA included an adequate margin of safety when it adopted these standards. There is no reason for Montana to go beyond that point.

R. First, the federal standards often do not include any margin of safety. The Environmental Protection Agency (Finklea, 1973) admitted that for many of the standards there is no margin of safety at all, and for some of them the "best judgement" of the threshold of effects is below the established standard. Second, the Department and the Board are charged by the Montana Clean Air Act with establishing air quality sufficient to be protective of human health. It is important that the Department conduct its own independent investigation.

C. If too great a margin of safety is used, it will be impossible to

gather information about the lowest levels at which health effects occur. If some people are not allowed to experience the adverse effects of air pollution, there can be no epidemiological experiments.

R. This irresponsible concept has been repeatedly denounced by responsible scientists.

C. It is necessary to rely on the whole body of scientific literature instead of a single study to establish that an effect can indeed be expected at a particular concentration and exposure time. The setting of standards should be guided by the consensus of the medical community.

R. To the extent possible, a wide range of studies should be consulted, but often there are only a handful of studies that have used concentrations at or near the current level of concern. The failure of one study to measure an effect at a given level does not mean that another study that observed an effect at the same level is necessarily in error. It means that a third study should be conducted for further definition. However, if the third study has not been done, the decision to err on the side of caution calls for setting a standard with the study that observed the effect.

C. The draft EIS fails (p.13) to consider factors such as genetics, plant development stages, temperature, light, humidity and soil conditions, all of which profoundly affect the growth, survival and response of vegetation to air pollution.

R. Vegetation is most susceptible to pollutants under certain environmental conditions and/or stages within their life cycle. If a standard is to be set to protect vegetation, it should be at a level sufficient to prevent adverse effects of plants even when the plants are in their most vulnerable growth stage during a time of adverse environmental conditions, such as dry weather, cold temperatures, and so on. It is scientifically interesting to determine what pollutant levels are injurious to plants during non-vulnerable periods, but such studies are of little use in setting ambient pollution standards.

C. Contrary to assertions in the draft EIS (p.15), the results of laboratory research on the sensitivity of plants to air pollution tends to understate pollution effects not only on laboratory plants but on similar plants growing under field conditions. Nevertheless, laboratory experiments more clearly define the potential effects of pollution on field plants, because such experiments allow the exclusion of all variables except those under the control of the experimenter.

R. There is considerable debate among plant scientists on whether laboratory experiments or field experiments are better for determining the threshold level where air pollutants begin to affect plants.

A laboratory experiment allows control of all environmental conditions that could influence the pollutant related effect on a given plant species. Such conditions include water, light, fertilizer, spacing, temperature, freedom from competition, insects, and disease.

Plants existing under field conditions must endure less than ideal combinations of the variables cites, so may be more susceptible to pollution than laboratory plants living under better circumstances. Even when laboratory fumigation experiments attempt to duplicate natural conditions they way underestimate the potential effects of pollution. Guderian (1979) said:

> Injury limits derived from fumigation experiments under conditions similar to natural conditions tend to be slightly higher than those derived from field studies, usually because of their shorter exposure times.

The Bureau therefore maintains that the experiments most appropriate for citation in defining an ambient air quality standard are those conducted under the environmental conditions typical of the area in question. Only under these conditions can an accurate evaluation be made of the pollutant levels, exposure periods, and environmental conditions that lead to environmental damage at a given pollutant level over a particular averaging period.

C. (p. 14) The margin of safety should vary with the severity of the effect. Where there is a possibility of incapacitating illness (or death) the margin should be large. For less serious effects it should be reduced or eliminated altogether. The approach of the Air Quality Bureau seemed to be the setting of a factor of two for most of the standards, although a factor of three was used in some instances, with no margin of safety at all in others. In one instance the use of both a daily and an annual standard was claimed to provide a margin of safety.

R. The draft EIS was not sufficiently clear in describing how a particular margin of safety was selected for a particular standard. Additional details have been provided in this final EIS. Severity of the effect was one of the elements considered in determining a margin of safety. It also was necessary to consider the uncertainty in the research results indicating that a specific effect resulted from a particular concentration of a given pollutant. A factor of two was selected as the starting point in the consideration of an appropriate safety factor. This approach appeared to provide a reasonable certainty that the concentrations in the air at locations near pollution sources would not exceed the standard if no ambient standard violations were recorded at adjacent monitoring stations. Variation of air quality seldom exceeds 50% if the monitoring site has been properly chosen initially. Also, the studies reviewed for the various pollutants seemed to indicate a factor of two provided a satisfactorily broad range to encompass most of the individual variability of reaction to a given pollutant concentration.

With this in mind, each proposed standard was individually evaluated in terms of the observed effects and the relevant studies. As suggested by the comment, the margin was reduced for less severe effects and increased for more severe effects. If the subjects of the studies were predominantly healthy young males, then then the margin was increased to protect people in frailer health. The margin also was increased if the effect was observed in a significant fraction of the population, since an increased likelihood of reaction made it more likely that adverse exposure would be experienced. The use of both a short-term and long-term standard provides some margin of safety since air quality data is not always log-normally distributed although it often is. In circumstances where the distribution is not log-normal the daily and long-term standards will more completely define the average exposures such that there will not be an unusually large number of days with observed concentrations just below the standard. This has much the same effect as a margin of safety.

The choice of margins for the individual standards is discussed further in the conclusions chapter of this final EIS.

C. The synergistic effects of phytotoxic and zootoxic gases are mentioned in the draft EIS (p.14) but the authors never deal with this problem or make any recommendations.

R. Interactions between air pollutants were considered in establishing the proposed ambient air quality standards. Although certain air pollutants sometimes act together to cause a greater than additive adverse response (synergism), the response in other cases appears merely additive and under certain conditions less than additive. The most commonly observed synergism is between ozone and other pollutants. Because of the rarity of elevated ozone levels in Montana, MAAQS did not assume the possibility of ozone synergism. MAAQS compensated for possible interactions among other pollutants by recommending a standard that would hold pollutants at levels too low to result in synergism. It seems apparent that under present Montana ambient conditions, most plants and animals will be protected from adverse effects (including synergism) at pollutant levels at or below those recommended in this final EIS.

C. The AQB recommendations (p.14) for sulfur dioxide failed to take into account the synergistic effects of ozone that caused California to adopt a tighter sulfur dioxide standard.

R. Although high ozone levels in California require such considerations, the infrequent and relatively low levels of ozone in Montana allow this effect to be disregarded in setting the standard.

C. In establishing a short-term standard it is necessary to consider the

previously established annual average and the variability of one-hour concentrations, as well as the health effects of the pollutants. For example, if reasonable assumptions are made about the characteristics of the log-normal distribution of one-hour concentrations then given the annual average of 0.05 ppm set for nitrogen dioxide, the one-hour standard should be in the range of 0.25 to 1.0 ppm, rather than the 0.17 ppm proposed in the EIS.

R. While it is useful to use the log-normal distribution of meteorological data to examine a set of possible standards to determine which might be the most difficult to achieve, it is not correct to use one standard to determine a range consistent with the log-normal assumption for the remaining standards for that pollutant. The Montana Clean Air Act requires the standards to be set to protect the public health. If the available data show that a stringent short-term standard is required but suggests a more lax long-term standard, then it is entirely reasonable to adopt a pair of standards for that pollutant that are not consistent with the commentator's assumed log-normal distribution of hourly concentrations.

C. Alternatives to each standard (making it more or less stringent) should have been presented in the Draft EIS.

R. It is not reasonable to suggest a standard less stringent than the federal standards since they would continue in effect whatever Montana does. On the more stringent side there is an infinite number of standards that could be selected, down to zero. The implications of standards other than the ones proposed by the Air Quality Bureau can easily be determined from the material in Chapter III of the Draft EIS.

C. The definition of annual average, hourly average, etc., will require extensive and costly monitoring by companies which are unlikely to violate standards.

R. The proposed rule says nothing about who will measure what air pollutants, or for how long. The rule defines how much data is necessary to obtain an annual average, hourly average, and so on. It was not intended to imply any responsibility for monitoring.

C. No definition of three-hour average is given. Why?

R. There is no definition for a three-hour average since there are no proposed standards using that averaging period.

C. The language for eight-hour average, twenty-four hour average, and thirty day average should be made more clear about "nonoverlapping" time periods.

R. Provisions of the final proposal of the Department will ensure that averaging periods will not overlap for purposes of enforcement.

C. Why does the Department find it necessary to have its own "equivalent methods" when the EPA has such requirements for continuous analyzers?

R. The federal EPA does not have "equivalent methods" for all air pollutants. The EPA equivalence applies only to ozone, carbon monoxide, nitrogen dioxide, lead, and sulfur dioxide. The equivalency does not apply to any of the following existing or proposed standards: settled particulate, visibility, hydrogen sulfide, fluorides and foliar fluoride. The Department does not want to remain inflexibly tied to the methods of air pollution sampling given in the rule. As new and better methods are found to sample such things as fluoride and hydrogen sulfide, a mechanism will be needed to allow their adoption not only by the Department, but by affected industry and independent researchers. Without Montana's own "equivalent methods" there would be no way to accommodate the data generated from these methods. The Department is proposing to allow the state the same options EPA has.

COMMENTS ON DEPARTMENTAL POLICY IN DEVELOPING AMBIENT AIR QUALITY STANDARDS

C. The proposed ambient standards rule must include a requirement for periodic review of the state's ambient standards, just as the Federal Clean Air Act has required regarding the national ambient standards.

R. The Montana Clean Air Act contains no requirement for periodic review of ambient air quality standards. The Department will continue to review the standards on an informal basis as additional information becomes available. However, the Department does not recommend inclusion in the rule itself of a requirement for general periodic review.

C. The DEIS does not point out that air pollution currently has only a minor impact on the human environment in Montana. Only a miniscule fraction of the state's surface area is exposed to pollutant levels in excess of the proposed standards. Therefore the benefits of the new standards are greatly overstated.

Moreover, unlike the sprawling industrial areas in more populated parts of the country, the few industrial areas in Montana are surrounded by "clean" air. Therefore, a person living in an industrial area in Montana will have an average annual exposure to sulfur dioxide lower than a person in a larger industrial area. This is true even though the same ambient standard applies in both areas. Consequently, Montana either should not adopt such a strict standard for sulfur dioxide, or no margin of safety should be included in the standard.

R. Ambient air quality standards are based upon protection of human health within the state. Neither the size of affected areas nor population densities are relevant to setting protective standards. Currently, air pollution levels are well within the proposed standards over most of the state. However, most of the state's population lives in the areas where standards are exceeded. The following table, which lists areas not yet in compliance with the national ambient air quality standards, is illustrative:

Table 4- Nonattainment Areas in Montana

	Carbon monoxide	Total suspended particulate (TSP)	Sulfur dioxide (SO_2)
Anaconda Area			X
Billings Area	X	X	
Butte Area		X	
Columbia Falls		X	
Cosltrip Area		X	
E. Helena Area		X	X
Great Falls Area		X	
Laurel Areal			X
Missoula	X	X	

Since the small surface areas affected by current pollution levels also contain most of the state's citizens, achievement and maintenance of the proposed ambient air stadards in these areas can yield substantial health benefits even though the areas are geographically small.

As for average annual exposures in industrial areas surrounded by "clean" air, the suggestion assumes that residents of an industrial area in Montana will spend a certain amount of their time in the "clean" air away from the industrial area. While this undoubtedly is true for many such residents, it cannot be assumed to apply to the population at large, including the elderly who may be especially susceptible to air pollution.

C. Contrary to the statement on page ii of the draft EIS, the Board never directed the Department to propose ambient standards which were enforceable. The Board's original interpretation of the standards as "goals and guidelines" is the proper approach and should be retained.

R. In November of 1977 the Board directed the Department to propose enforceable ambient standards. The Board may not fully have appreciated the distinction between directly enforceable ambient standards and ambient standards enforceable only through emission standards. However, the Board was clear in its direction that the Department propose ambient standards which had the force of law.

Ambient air quality standards which operate as "goals and guidelines" are limited in their usefulness. Such standards provide fewer incentives for compliance and lack the regulatory certainty which is assured by enforceable standards.

C. Strict ambient air quality standards for sulfur dioxide and particulate matter are not necessary in Montana. The regulations on prevention of significant deterioration (PSD) will insure that the excellent air quality in large areas of the state will not deteriorate even to levels far better than required by the national ambient air quality standards.

R. The federal regulations on prevention of significant deterioration (PSD) recently have been, with minor exceptions, incorporated as part of the revised state implementation plan (SIP) and will soon be administered by the Department.

For the most part, the prevention of significant deterioration (PSD) regulations will not allow significant increases in the low levels of sulfur dioxide and particulate matter currently found in large areas of the state. In practical terms therefore, large areas of the state will have sulfur dioxide and particulate ambient standards more stringent than those recommended by the Department.

EPA recently proposed important changes to the PSD regulations which could affect the PSD rule incorporated into the Montana State Implementation Plan (SIP). The impact of the final PSD rules upon protection of air quality in Montana is yet to be determined.

The Montana Clean Air Act requires the Board to ensure levels of air quality which will, at a minimum, protect human health. Establishment of minimum health-based air quality standards across the state is preferable to reliance upon a relatively new program which is still evolving as an effective regulatory tool.

C. Many of the state's major industrial sources currently are carrying out their obligations under long term compliance schedules agreed to by the Department and approved by the Board. The recommended ambient air quality standards would initiate a whole new round of compliance for some or all of these sources. The Department and the Board are legally and morally bound to the current compliance agreements and should not impose new requirements.

R. The emission reduction plans to which various sources have agreed are not contracts but are conditions required by the Department for the continued operation of a facility not in compliance with an applicable law or regulation. Regulated sources therefore have no right to these variances nor to the specific operating conditions the Board has deemed appropriate to accompany them. The proposed ambient standards may or may not impose new compliance requirements on specific sources. Most sources should be able to comply with the proposed standards with their current programs of emission control. Some sources may require additional abatement.

C. The Department has proposed to subject pollution sources to civil and criminal penalities for violations of the ambient air quality standards. The Montana Clean Air Act does not authorize directly enforceable ambient standards. Rather, the Act specifies (Section 75-2-203) that emission limits are "controlling" and are therefore the only legitimate mechanism for enforcement of ambient standards.

R. Section 75-2-401 (Enforcement) of the Montana Clean Air Act authorizes the Department to issue a notice for a violation of any rule adopted under the Act. Sections 75-2-412 (Criminal Penalties) and 75-2-413 (Civil Penalties) provide for the seeking of penalties for violations of any rule or order made under the Act. No exception is provided in any of these three sections for the Ambient Air Quality Standards rule. Section 75-2-203 (Board to set emission levels) providing that emission limits set by the Board shall be "controlling," has application only internally within section 75-2-203 and has no effect upon the authorizations contained in sections 75-2-401, 75-2-412, and 75-2-413.

C. The definition of "ambient air" proposed by the Department is vague and cannot be justified either by the possible purchase of land adjacent to a pollution source or by the protection of state-owned wildlife as suggested on page 18 of the DEIS. Moreover, the Clean Air Act does not authorize the state to take any action to prevent establishment of a company town, even if a company should try to organize one to frustrate the Act.

R. After reviewing its original proposal, the Department has modified its definition of "ambient air." The new definition allows enforcement of ambient air quality standards in all areas to which the general public has access. A discussion of the Department's modification appears in Chapter 4 of this final EIS.

C. The Department's policy of setting standards to protect human health regardless of emission control costs is a distortion of the mandate of the Montana Clean Air Act. The law requires the Department and the Board to administer the law so as to promote economic development and provide a framework in which all values may be balanced. Considerations of practicability must therefore enter into the setting of human health standards.

R. The Montana Clean Air Act imposes a duty upon the Board to set ambient air quality standards, which, at a minimum, protect human health and safety.

Once an acceptable level of air quality is determined, the Board may make the ambient standards even more stringent after weighing the social and economic considerations specified in the law. It is in the balancing of these specific welfare considerations that practicability is to be weighed.

C. The Montana Clean Air Act neither authorizes nor requires the use of a margin of safety in setting ambient air quality standards. The Act requires that if any margin of safety is needed, it should be the smallest consistent with the protection of human health.

R. The Montana Clean Air Act defines air pollution as "the presence of one or more air contaminants in a quantity and for a duration which are or tend to be injurious to human health or welfare . . . ."

The tendency of particular air pollutants to have adverse effects on human health is subject to varying degrees of uncertainty. Sound public health practice dictates that standards designed to protect human health make some allowance for uncertanties concerning the severity of effect and the degree of understanding about a pollutant. The selection of a particular margin of safety is based upon the acceptability of risk associated with the pollutant in question.

C. The draft EIS says that the body may respond to even the lowest concentrations of some pollutants. That is, there may not be an effects threshold for these pollutants. While this may be true for very minor effects, there may be a distinct threshold which marks the onset of clearly adverse effects.

R. The suggestion in the comment is well-taken. The Department has clarified its use of a similar concept in establishing for each health-based standard a "level of apparent health response." This is the pollutant level at which health-related responses begin to be observed.

C. The hourly carbon monoxide standard, with a safety factor of two to three implies that Montana has more concentrated populations than the nation at large. How will the Department enforce this standard since carbon monoxide is produced primarily by cars and trucks?

R. The Department is proposing an 8-hour standard of 9 ppm which is identical to the federal 8-hour standard. The proposed Montana 1-hour standard of 23 ppm is somewhat more stringent than the federal 1-hour standard of 35 ppm. The Department considers the federal 8-hour standard sufficiently protective but prefers a somewhat wider margin of safety than the federal 1-hour standard currently provides. The margin of safety for each pollutant is based upon an assessment of acceptable risk associated with each pollutant. The EPA currently is reviewing its standards for carbon monoxide.

The Department cannot predict how carbon monoxide violations will be prevented. The Montana State Implementation Plan (SIP) contains several strategies designed to achieve attainment of the national standards for carbon monoxide. Other strategies, including those implemented by other states, may also be considered.

C. The Montana Clean Air Act, the Montana Environmental Policy Act, and the Department's regulations require that the DEIS present a cost-benefit analysis of the proposed standards and of each alternative to the proposed standards.

R. The Montana Clean Air Act requires that standards must be established which, at a minimum, will protect human health. Economic costs and benefits are not relevant to the setting of such standards. Standards based upon welfare considerations include consideration of estimated benefits and costs of the proposed standards.

The Montana Environmental Policy Act (MEPA) requires a discussion of alternatives to the Department's proposal. The Department rules adopted to implement MEPA require a discussion of the economic and environmental cost and benefits of the proposed action. Similar information concerning alternatives must be provided if it is available.

The Department has made every reasonable effort to collect and assess the environmental and economic costs and benefits of the proposed rule and its alternatives. Some of these cost and benefit components are less difficult to estimate than others. For example, the DEIS included estimates of the control costs which the proposed standards would impose upon each of the major industrial sources in the state. While some differences of opinion may occur as to the degree of emission control needed to meet the standards, the cost of pollution control equipment is reasonably ascertainable.

On the other hand, the economic benefits of improved air quality are more difficult to translate into dollar terms. Reducing the impacts of air pollution upon the human and nonhuman environments is generally regarded as beneficial. Even where pertinent information is available, the economic benefits of reduced air pollution may generally only be estimated within a range of dollar amounts.

In an attempt to estimate the environmental and economic costs and benefits of the proposed ambient rule, the Department entered into a research contract to support a study entitled, "Some Economic Aspects of Air Pollution in Montana" by Otis _et al_. The scarcity of information concerning the economics in air pollution limited the report to consideration of only two pollutants, sulfur dioxide and fluoride. Other impacts of the proposals and alternatives have been estimated, largely in qualitative terms. The number of unknowns and variables pertaining to these impacts have restricted the depth of the Department's analyses.

C. In any case where the Department is basing a standard upon considerations of practicability, a cost-benefit analysis must be done. Such standards must be economically justified in light of their impacts upon economic growth and jobs.

R. The Montana Clean Air Act requires the Board to weigh four welfare objectives in determining the practicability of requiring air quality better than necessary to protect health. A dollar for dollar cost benefit analysis is not required by the Act as is suggested by the commentator. Indeed, considerations such as protection of plant and animal life, socioeconomic growth, social comfort and convenience, and enjoyment of natural amenities hardly lend themselves to direct economic comparisons. The Clean Air Act contemplates a balancing of objectives to serve the interests of the state as a whole. The Department has utilized available economic information and has generated data along these lines to make its assessment of practicability as complete as reasonably possible.

C. The Department proposes to make the ambient air standards directly enforceable against pollution sources, in which case sources in compliance with emission standards could still be subject to civil and criminal penalties if ambient standards were exceeded. Subjecting a source to a fine or criminal penalty after an ambient violation does little to protect public health if the emission limits aren't revised when they are found to be inadequate. If an ambient violation occurs, the proper approach is to adjust the emission standards to prevent further ambient violations. This is the method used by EPA and most states to enforce ambient air standards.

R. The Department's chief responsibility in its air program is to maintain the quality of the ambient air, that is, the air people breathe as they go about their everyday activities. Administrative and judicial remedies are, along with the adjustment of emission standards, important tools for the enforcement of standards to ensure that acceptable levels of air quality are maintained.

The suggestion in the comment that the federal Environmental Protection Agency and most states enforce ambient standards exclusively through emission standards is only partly accurate. It is true that the EPA relies largely on the states to bring about attainment and maintenance of ambient standards and therefore does not generally undertake enforcement actions for ambient violations.

However, the laws in most states authorize the issuance of administrative orders for ambient violations and the laws of approximately one-half of the states also authorize court imposition of civil or criminal penalties for ambient violations. While administrative orders are commonly used, it is apparent that civil and criminal remedies are not frequently sought by many states authorized to use them. The actual extent to which administrative and judicial measures are used is determined by the needs and policies of the respective air pollution control agencies.

The imposition of a civil fine or a criminal penalty after an ambient violation would be too late to prevent any harm to health or welfare that might have occurred. Nor could the adjustment of an emission standard prevent harm from past pollution. However, the imposition of a civil or criminal penalty can provide incentive for future compliance. More importantly, the primary objective of a civil action brought by the Department is not the imposition of a fine but rather is a judicial order to end the noncompliance. In this light, the option to seek judicial remedies provided to the Department in the Montana Clean Air Act is an effective means of protecting public health and welfare.

C. The Department proposes to use administrative and judicial remedies to enforce the ambient air standards against pollution sources. In multi-source areas it is very difficult to prove that emissions from a particular source are responsible for an ambient violation. Moreover, sources in such areas may have to predict or attempt to influence the behavior of other sources in the area to avoid potential liability for violation of ambient standards. When a new plant moves into an area all existing plants in the vicinity might have to improve their pollution control. The regulatory uncertainty associated with directly enforceable standards cannot be justified. Ambient standards should be enforced only through emission standards.

R. Emission standards play a central role in the achievement of air quality standards. However, the Montana Clean Air Act expressly provides that all rules adopted under it are to be enforceable by administrative and judicial remedies. The adoption of a rule limiting the enforceability of the ambient air quality rule would be an unauthorized waiver of specific provisions in the Act and would prescribe an enforcement policy substantially different than that provided by the Legislature. Therefore, enforcement of ambient standards through emission standards alone is not an option available to the Board.

Furthermore the presence of multiple sources of a pollutant in an area does not preclude the direct enforcement of ambient standards there. Every source has characteristic emissions which may be identified by their physical or chemical properties. Sources in violation also may be distinguished with the help of meteorological observations and intensified monitoring efforts.

As for new sources wishing to locate in multi-source areas, the Department wields substantial control over the emissions of such sources through its air quality permitting process. Generally, it is preferable to impose strict conditions upon a new source rather than to require the retrofitting of existing sources. Thus, the siting of a new source in a multi-source area would rarely if ever require all existing sources to change their control equipment.

C. The draft EIS at p. iii says the proposed hydrogen fluoride standard is based upon injury known to cause substantial economic damage to plants and animals. However the Department nowhere discusses the concentrations necessary to cause "substantial economic damage." Moreover, the Department has based its standards on studies showing only slight or cosmetic injury to vegetation and cattle rather than on studies showing substantial economic damage.

R. The language on page iii of the DEIS is intended to point out that the hydrogen fluoride standard, unlike most of the other proposed standards, is based upon damage to plants and animals rather than upon considerations of human health.

It should not be read to mean that the fluoride standard is intended to prevent only substantial economic damage. The standard is based upon a variety of studies indicating a range of effects. Ultimately the standard is derived from considerations of practicability as required by the Montana Clean Air Act.

C. The proposed lead standard is unnecessarily stringent in light of the small area affected by excessive soil lead.

R. The proposed standard was based on a level low enough to preclude health effects in the most sensitive portion of the population, under Montana conditions. Ambient air quality standards are based upon health considerations. Neither the size of affected areas or population densities are relevant to the setting of standards intended to protect health across the state.

C. The standard proposed for settled particulate is based on a nuisance criterion and, as such, should be applicable only in residential areas, not rural or industrial areas.

R. It is difficult to differentiate among rural, residential, and industrial areas. Populated residential areas are often adjacent to or integrated with industrial areas. In addition, some industrial sources are located in areas away from urban centers.

Under the Department's modified definition of "ambient air," the settled particulate standard would not be enforceable at industrial sites.

C. The existing Board of Health order recognizes the cyclical nature of emissions from copper smelting as it permits a six-hour average to be used in calculating the permitted emissions from the Anaconda smelter. It has been agreed that the average emissions could be 16,800 lbs per hour. By adopting a one-hour standard for sulfur dioxide the Department will force Anaconda to meet an emission rate of 8,800 lbs/hr each and every hour. Further, if the definition of ambient air being anywhere on the property is used, it could require a reduction to less than 1,000 lbs/hr. Anaconda does not believe this is technologically possible.

R. The ambient standards were set to protect the public health, without consideration of the difficulty one source might have in meeting it. The one-hour standard is designed to protect the public from excessive exposures of short duration. The adoption of the standard would not amend the previous order of the Board of Health. The definition of ambient used in the proposed rule in the draft EIS has been modified to exclude property owned by the source, unless the general public has access.

A consultant's report to Anaconda indicates that the violations at the West Gate are due primarily to fugitive emissions. It is precisely this type of emissions that Anaconda's new control program is designed to reduce. The Department estimates that with the new program in place the predicted maximum concentration should be lower and, quite probably, within the proposed one-hour and 24-hour standards. The violations at Highway Junction are due primarily to the main stack. The consultant's report predicts that the maximum concentration there will rise to but not violate the proposed standards once a year when the new control program is implemented. This calculation assumed an emission rate of 16,800 lbs/hr. The Department estimates that the actual emissions will be significantly less than this.

COMMENTS ON ECONOMIC ASPECTS OF AIR POLLUTION

C. It is not correct to say (p. viii) that Montana will save $17.1 million a year by adopting the proposed standards. Only the savings achieved by moving from the federal standards to the more stringent state standards is relevant. Further, it is not proper to discuss the costs of pollution control equipment in terms of a straight-line depreciation.

R. You are correct. An economic study by the Department (Otis et al. 1979) calculates the savings of moving from the federal standards to the more stringent proposed state standards to be between $1 million and $4 million per year. The annual control costs of the control equipment necessary to achieve the more stringent state standard is between $1 million and $6 million. These costs are estimated using the correct economic techniques. The costs appear to be approximately equal to the benefits.

C. In the initial working paper it was said that for standards not based on health effects the costs of control would be a major decision and a "relatively complete cost benefit analysis" must be made. No "relatively complete cost benefit" analysis was made for fluoride, settled particulate or visibility.

R. A literature search performed after issuance of the working paper revealed the time and money necessary to perform such analyses was not worthwhile for visibility or settled particulate. It was noted that establishment of these standards would have little immediate financial impact on any source. The economic analysis for fluoride is as complete as it could be on the basis of available information.

C. The Department has not analyzed the economic costs of achieving the federal standards versus achieving the Montana standards.

R. This was analyzed for sulfur dioxide in a study by Otis et al. (1979). The study is available from the Department. This work was not done for other pollutants because the necessary data were not available.

C. The reported costs to the industries for pollution control equipment ignores the subsidy of 30 to 50 percent of the costs funded through tax loopholes.

R. In making a social benefit-cost analysis it does not matter who pays the cost or who benefits. The calculation is concerned with the total social cost. The cost of control to the society is the same if all of it is paid by the companies from profits, or if part of it is paid by the community through their taxes or higher prices. Similarly the savings in reduced health costs or vegetation damage will remain with those who avoid illness or have an increased harvest, but the analysis counts this as benefiting the whole society.

C. The Otis et al. paper assumes (p. 242) a value for one life of $300,000 instead of a more accurate value of $50,000. The estimate is based on the work of Thaler and Rosen who studied the premiums required by young workers to enter hazardous occupations. It is too high for older workers who are not economically productive.

R. That is an erroneous reading of the Thaler and Rosen paper. They observed that the annual risk premium was approximately constant across age for all workers. Furthermore, their estimate is generally accepted as being low due to the lower than average risk aversion of the workers in these particularly risky occupations. Smith's (1976) work is perhaps more accurate. He calculates $2.2 million in 1978 dollars. The Thaler and Rosen number was chosen to underestimate the social benefits. The $300,000 estimate does not fully reflect inflation to 1978, so it has been adjusted in the final report to $400,000.

C. Some of the people who will die from air pollution are unemployed and therefore have no economic value.

R. While some may calculate expenditures in this way, it is not a legitimate approach for a state agency.

C. The Otis et al. paper (p. 242) arbitrarily doubles the mortality costs to obtain morbidity cost estimates. This results in a serious overestimate.

R. This was due to a misreading of the Lave and Seskin study. It has been corrected in the final draft of the Otis et al. study.

C. The reduction in air pollution will not result in any economic savings. If reducing air pollution reduces illness, doctors will just increase their fees and surgical workloads enough to protect their incomes.

R. It is probably more correct that medical service would be reallocated to ailments that currently are slighted, with more detailed service going to the remaining workload, and provision of services to patients who cannot now obtain them.

C. The economic analysis understates the agricultural costs by ignoring long term effects of pollution on soils, water and animals.

R. The calculations of current damages are so uncertain that to include any estimates for long-term loss would reduce the estimates to mere speculation. A known underestimate is preferred to a possible overestimate.

C. The costs of pollution control equipment (p. 243) would be far less for new plants coming into the area than for retrofitting existing plants. Therefore, the benefit/cost ratio would increase in the future.

R. While it is generally true that it is cheaper to design control equipment into the production facilities at the outset rather than retrofit, it is not possible to accurately estimate future control costs without reference to a specific facility. Since there is no solid information on any proposed new facility, there can be no more specific response to this comment.

C. The EIS suggests (p. 239) that expenditure of approximately $2 million for improved hooding and scrubbing in the furnace system may be necessary to provide adequate protection to plants and animals in the vicinity of the Stauffer plant. Such controls would not measurably reduce the fluoride emissions since it has been recognized that this part of the plant contributes no more than 50 lbs/day of total fluoride emissions.

R. The Department agrees that the kilns are probably the largest source of fluorides and acknowledges that the kilns are controlled to the greatest feasible degree. However, the Department concluded that improved collection at the hoods and the slag runner area could result in more control. The Department concedes some uncertainty here and believes that the achievement of the necessary reduction depends heavily on the success of the slag granulation program.

C. The Otis <u>et al</u>. values for visibility damage are entirely arbitrary and unrelated to the real world.

R. They were obtained by asking people how much of an increase in their monthly electricity bill they would accept to prevent degradation of visibility from a new coal-fired power plant.

C. The Department does not have adequate air monitoring data for Billings, so it is not known if the installation of control equipment would result in achievement of the ambient standards. The cost of the monitoring equipment is not discussed in the EIS.

R. No new control equipment would be required of a company under the proposed standards until adequate air quality monitoring had been completed. A monitoring system for Billings is now being deployed.

C. The draft EIS reports (p. 232) a cost for further sulfur dioxide control at ASARCO that is significantly different from the cost estimated in the Otis et al study.

R. Since the draft EIS was published ASARCO has given the Bureau a detailed cost analysis to support their estimate of $6.2 million dollars for the cost of the proposed modifications. The Bureau is grateful for this cooperation with the EIS process. Review of the estimate revealed that it included a total reconstruction of the main sinter machine and modifications to improve the operation of the machine. The changes for air pollution control alone appear to account for less than one-third of the projected costs. The Bureau therefore now estimates the costs to be in the vicinity of $2 million.

C. The draft EIS does not give sufficient discussion of the direct costs of compliance with the proposed standards.

R. To determine the actual costs of compliance for a specific company it is necessary to know, first, how much reduction in emissions will be necessary to achieve the standard. To determine this it is necessary to have detailed knowledge of the meteorology in an area and the present levels of pollution. Collecting such data is extremely expensive and requires at least a year, if not longer. Second, there must be detailed engineering analysis of a specific plant and the various ways the process could be changed or control equipment added. This is an exacting task and the number of sources to be considered makes the expense too great to be borne by the public. Therefore the cost data presented are developed by analogy to similar problems and their solutions in other plants. They are not claimed to be more than an approximation of the probable cost.

C. The control cost estimates for the Corette Plant (p. 237) should be qualified as only a rough estimate. A detailed design study would be needed to precisely define the cost.

R. Costs are particularly difficult to estimate when control equipment must be installed on an existing plant. As the draft EIS points out, site specific factors could add additional cost.

C. The estimated cost (p. 237) of a coal cleaning plant may not apply to Rosebud seam coal. What is the source of the data?

R. Holt, E. C. 1978. An Engineering/Economic Analysis of Coal Preparation Plant. (EPA 600-7/78-124).

C. The draft EIS refers (p. 237) to the Corette pyrite removal process as "screening." It is more correctly termed "air classification." It is done in the crushing mills.

R. Comment noted.

C. In its discussion (p. 237) of possible further sulfur dioxide controls for the Corette plant in Billings, the EIS says a lime scrubber could be used and that the energy demand for such a scrubber would be up to 2 percent of the plant's electrical production.

Such an estimate of energy demand is premature because the actual figure would depend on the specific design of the device as well as on the plant load. Moreover, a calculation of energy demand based on Colstrip 1 and 2 may not be valid for the rather different installation that would be required at Corette.

R. It is agreed that the specific design of a scrubber(s) would dictate actual energy consumption. However, for purposes of estimating energy demand, the 2 percent figure is a reasonable approximation.

C. The economic analysis (p. 243) assumes that sulfur dioxide currently exists at or above the federal standards throughout the state. In fact, only a small fraction of the state now experiences excess concentrations of pollutants.

R. This is a misunderstanding of the Otis et al. study. The health and materials damage estimates are based on fractions of the local population associated with existing air quality monitoring stations. Where no monitoring station exists, the sulfur dioxide level was assumed to be zero. The vegetation damages are based on county-wide damage functions, adjusted to reflect the gradation of pollution across a county from near-source high concentrations to zero concentrations away from the sources. Only four counties were assumed to have sulfur dioxide levels of any consequence. The remaining counties were assumed to have no sulfur dioxide exposure at all.

C. It is not valid to project health costs for Montana based on studies done in large industrialized cities. These studies do not take into account the stress of such things as city living and diet.

R. Numerous studies conducted by different authors using different methods and different data bases have all produced approximately the same results. While none of the studies should be assumed, by itself, to be valid for extrapolation to a new situation, the existence of supporting evidence makes possible the use of coefficients from these studies for estimation purposes.

C. The Otis et al. study should be revised to utilize more conservate estimates of health effects and the costs of morbidity and mortality. Their estimates are not consistent with the methodology of Lave and Seskin.

R. The study has been revised as suggested.

C. The entire calculation of health benefit is unjustified since (1) there are no health effects at current levels of air pollution in Montana and (2) it is based on the Lave and Seskin study, which is of no use as a measure of air pollution health effects.

R. The Lave and Seskin study assumes there is no threshold of health effects, an assumption supported by numerous studies cited in the draft EIS. It is accepted that there are serious difficulties in conducting any study of that type. However, if one is to make an estimate, some study must be chosen to provide the damage function. The Lave and Seskin study is as good a candidate as any.

C. While the EIS said very little data is available on sulfate levels in Montana, other parts of the EIS and the Otis et al. study rely heavily on sulfates data, especially visibility degradation tied to sulfate in air.

R. Although limited, the information on sulfates in Montana is sufficient to demonstrate that the conditions are similar enough to those in other areas to allow the results to be applied to Montana.

C. The Lave and Seskin study uses air pollution data from the center of the city to compare with mortality rates for the whole city. This casts considerable doubt on the whole process.

R. This is a problem with accuracy of the study but a careful analysis of the implication of this difficulty will show that it tends to underestimate the effect.

C. Lave and Seskin failed to account for cigarette smoking. That could be the source of their entire correlation between air pollution and mortality.

R. Schwing and McDonald (1976) accounted for cigarette smoking and found the same things as Lave and Seskin.

C. A study by Cooper and Hamilton applied a more powerful regression technique to Lave and Seskin's data and did not find a correlation between air pollution and mortality.

R. The procedure used by Cooper and Hamilton is designed to discriminate against variables that account for only small changes in the variation. It is particularly hard on multicolinear variables, which account for almost all air pollution variables. It is not correct to call the procedure "more powerful." It is just different.

C. An economic analysis should be presented on the relative contribution to particulate pollution of agriculture, unpaved roads and surface mining.

R. At the present time there is even less information available to do such an analysis than is available for other pollutants. It would require basic econometric research.

C. If the estimates in Fishelson and Graves (1978) of the costs of illness are correct, then the savings in Montana of meeting the proposed standards is only $6 per person per year.

R. The Fishelson and Graves figure of 10¢ per capita per ug/m^3 of sulfur dioxide reduction applies only to the costs associated with sudden cardiac arrest. It is as accurate an estimate as any for that single disease state. It should not be stretched beyond its range.

C. The Otis <u>et al</u>. vegetation damage study assumes that the sulfur dioxide levels are uniform throughout each county.

R. This is a misunderstanding of the SRI approach. The table of coefficients is designed with the assumption that the concentration will fall off from a high value at the source to a low value at some distance away. Thus the coefficients are deliberately set much lower than they would be to reflect only the damages near the source.

C. Does the Otis et al. study assume that the air pollution levels presently existing in the state are now at the federal standards and benefits will be gained by reducing these to the levels proposed in the state standards? Since much of the state is much cleaner than the federal standards, this will result in overstating the value of reducing to the state standards.

R. The computations by Otis et al. used actual measured values of the sulfur dioxide concentrations in three urban areas: Anaconda, Helena and Billings. A value was counted only when the existing concentrations were above the state standards.

C. The Otis et al. study did not include any value for the damage to eastern Montana rangeland from air pollution. This will result in an understatement of the true damages.

R. Sulfur dioxide concentrations are extremely low in rural areas of eastern Montana, except near specific sources such as power plants. Even there the concentrations are not high enough to cause immediate effects on crop yield. In these areas the new standards would have no effect on future economic losses due to new sources since the Prevention of Significant Deterioration rules will control construction in these areas, not the ambient air quality standards.

C. The EIS states that the costs of controlling emissions from the ASARCO dross-reverberatory building could be defrayed by the value of lead particles recovered. However, such savings could not possibly exceed $50,000 per year.

R. Comment Noted.

C. The estimated costs of controlling airborne lead emissions are apparently based upon the experience of facilities other than lead smelters. Much more carefully computed costs should be obtained and analyzed before estimating ASARCO's costs.

R. The facility analyzed is sufficiently similar to the dross-reverb building that the cost estimated is adequate to the needs of an environmental impact statement.

C. CENEX is presently committed to spending about $5 million to meet the present standards. Depending on the final definition of "ambient" it may be necessary to spend up to $80 million for fuel gas desulfurization to meet the standards.

R. The definition of "ambient air" will not be significantly different from the definition that was in use when CENEX designed its present proposed control program. It is anticipated that full implementation of all the proposed changes will achieve compliance with the standards.

C. The analysis should have included the secondary economic impact of a potential closure of the sources or restraints on the future growth of these plants.

R. The problem of what secondary impacts to include in a benefit-cost analysis is much debated. It is clear that to count the spending of income by plant employees or the local purchase of materials by the plant would result in double-counting of the social economic costs. If one wishes to examine only the local impact then this approach could be taken, but it will always result in a lower apparent cost, since much of the employees' incomes and many of the control equipment expenditures find their way into pockets outside the state. The method of counting only initial expenditures tends to overstate the effect on the local community. To calculate the present value of future growth in employment and production growth would require information that is usually only available as speculation and wishful thinking.

C. The economic analysis of the proposed standards must include the costs of required monitoring, enforcement actions and public loss of access to private lands.

R. A necessary cost in achieving any ambient standard is the cost of monitoring and enforcing the standards. This cost was not included in the Otis et al. study since its primary focus was a comparison of the state and federal standards. It is assumed that the same funds will be appropriated by the legislature whichever standard is adopted. If the definition of "ambient air" for enforcement of the standards does result in private lands being closed to public use that will impose an additional, uncounted cost on the public. This was assumed to be small by comparison to the other values computed by the study.

C. The copper smelting industry is concentrated in only a few states. Of the states with copper smelters, only Washington has standards as stringent as those proposed by Montana. That will put Anaconda at a serious economic disadvantage with respect to the rest of the industry.

R. The other states have adopted the Federal standards of 0.5 ppm for three hours and 0.14 ppm for twenty-four hours. The State of Washington has adopted a one-hour standard of 0.4 ppm and a twenty-four hour standard of 0.1 ppm. Further, the Washington standard is enforceable and has been enforced (with the collection of fines) against several sources, including a copper smelter. However the required air quality standards are only a small part of the cost structure of a smelter. Transportation, energy, and labor costs are also very important. All of these must be considered in estimating the economic advantage of a particular facility.

The cost to an industry of achieving compliance with a particular standard is also a function of the local meteorology and the particular equipment in the plant. Thus two plants facing the same standard might have substantial differences in their costs. To determine if a proposed standard does, in fact, place a company at a substantial disadvantage to its competition would require a specific study of the plant and the economic structure of the industry.

C. The Anaconda Company estimates that neutralizing sulfuric acid, if necessary, would cost $8.5 million annually, not the $2 million quoted in the draft EIS. The energy consumption would be high.

R. The material provided by Anaconda indicates that the company estimate is more accurate than the one in the EIS. This suggests that neutralization is not a realistic alternative. Lower cost options for disposal of the acid will have to be found if markets are not readily available. At that price Anaconda could save money by subsidizing the sale into almost any U.S. marketing area.

C. The EIS estimate of $43.5 million in capital costs and discounted operating costs Anaconda would have to incur to comply with the proposed standards is a substantial underestimate.

R. On the contrary, the EIS appears to have overestimated the costs. The increased acid plant capacity can be provided for approximately $21 million, with an annual operating cost of about $1 million. Other controls required at the plant are quite expensive, but they are more directly related to occupational health than to control of ambient sulfur dioxide.

C. The Otis et al. study assumes that the health effects of sulfur dioxide can be represented by a straight line dose-response function. There is no data to support this. Most health effects researchers tend to use a sigmoid form, which would mean less effect at lower exposures.

R. The sigmoid (S-shaped) curve has customarily been used in health effects research since it is observed in experiments with the concentrations of pollutants that will kill a certain percentage of test animals. It is probably the best guess on the shape of the dose-response curve for acute toxicity, but the effects modeled in this case are expected to be entirely in the initial linear section of the curve. Tests on the data carried out by Lave and Seskin and by Mendelsohn and Orcutt indicate that this is the case.

C. The Otis et al. report estimates that the proposed annual sulfur dioxide standards would reduce damage to materials and save approximately $187,500 annually. However a more realistic approach would place such savings at $59,000 annually.

R. The Otis et al. calculations were modified as you suggested. This yields an estimate of the materials benefits of achieving the federal standards of $104,000 a year and at $125,000 a year for achieving the state standards. Thus the estimated savings is about $21,000 annually for adoption of the proposed state annual standard. The damages to materials are the smallest part of the calculated economic effects, primarily because the dry climate is not conducive to sulfur oxides corrosion.

C. Montana would save about $8 million by adopting the proposed 0.02 ppm state sulfur dioxide standard.

R. The additional annual savings to Montana residents of adopting an annual standard of 0.02 ppm for sulfur dioxide has been calculated by Otis et al. to be between $1 million and $4 million. However, this would be matched by the cost to industry of controlling the pollution. Rather than a savings it should perhaps be seen as an end to subsidies by state residents, to out-of-state stockholders in these companies.

C. It would be far more difficult for Anaconda to meet a one-hour standard than a 24-hour standard. The AQB as recognized this in previous control orders. Yet your estimates of control cost are based entirely on controlling to meet the 24-hour standard.

R. It is acknowledged that, depending on the standard adopted, it might be more difficult for Anaconda to meet the one-hour standard than the twenty-four hour standard. Exactly how much more control would be required is not clear. Similarly, it would be easier for Anaconda to meet the annual standard than the twenty-four hour standard. The Otis et al. studv is based on a comparison of the costs and benefits of the annual standard. Thus, the use of the costs of meeting the twenty-four hour standard will not result in an understatement of costs appropriate to that study.

C. Paving of haul roads would cost more than the EIS suggests. Watering may be more efficient.

R. This is correct. The EIS should have drawn a distinction between city streets and mining haul roads. The $30,000 to $35,000 per mile paving costs cited in the draft EIS apply to normal streets and roads used by a traffic mix of light duty vehicles and some medium and heavy duty vehicles. Paving for a haul road in a mine would require substantial road bed preparation and extra layers of paving. Cost could exceed $100,000/mile. Furthermore, heavy vehicles could cause rapid deterioration of the surface. It is estimated (EPA, 1976) that paving results in 85 percent control. Sampling done in Montana (Air Quality Bureau and Midwest Research Institute, 1978) shows that paved industrial roads exhibit emissions of approximately 1/20 of that from similar roads with no paving, representing a 95 percent control efficiency. Road watering, depending on how intensely it is performed, can result in control efficiencies of 0 to 80 percent control. These figures indicate watering may be the more cost effective of the two. Dust suppressants may however be a better alternative.

C. The estimate for 1977 sulfur dioxide emissions from the Corette Plant are given in Table A-1 as 9,986 tons. The Montana Power Company has estimated those emissions to be between 9,557 and 10,076 tons/year.

R. The Department's data indicate that approximately 95 percent of the average sulfur input in coal to the Corette plant is converted to sulfur dioxide. Based on this assumption, the Corette plant would emit an estimated 9,986 tons per year, as stated in the EIS. However, data from source testing performed at Corette in 1978 indicate that the sulfur dioxide emissions from the plant might have been as high as 12,030 tons in 1977.

C. Contrary to the EIS, (p. 44) The Montana Power Company's figures indicate that the Corette coal fired power plant burned 248,330 mcf of natural gas for flame stabilization in 1977. The average net load for 1977 was determined to be 132,321 kilowatts.

R. A recheck of the Air Quality Bureau files indicates that the Corette plant operated for 8090 hours in 1977 and had a net generation of 1,097,255 MW hours as stated in the draft EIS. This results in an average net load of 135,631 kilowatts which approximates an average gross load of 143-144 MW. The 144 MW given in the draft EIS is an approximate gross generation figure which could vary.

C. The EIS indicates (p. 45) that the sulfur content in the coal used in 1977 at the J. E. Corette plant was 0.84 percent or 5,236 tons. The EIS also suggested that the Corette plant's pyritic rejection process removed from 5 to 10 percent of the sulfur in coal used.

The Montana Power Company's figures show that the sulfur content was actually 0.83 percent for 1977 or 5,193 tons. Moreover, the company's initial data indicate sulfur removal via pyritic rejection in the range of 10 to 15 percent.

R. The Department's files indicate sulfur content at 0.84 for 1977. The Department has no data to substantiate the suggested 10 to 15 percent removal by pyritic rejection. It appears in the absence of such data that the 5 to 10 percent figure is more reasonable for western coal.

C. The EIS is incorrect in saying (p. 49) that the highest ambient particulate concentrations "appear to be related primarily to fugitive dust from various sources." High levels were recorded in Missoula in winter when there was no possibility it was road dust because of snow on the ground. Fugitive dust contributes to TSP, but is not the primary source.

R. Although it is accurate to say that high ambient TSP concentrations may occur without contributions from fugitive dust, it remains true that the highest concentrations result directly from fugitive dust.

C. The draft EIS says (p. vii) "A substantial amount of particulate matter released into the air in Montana comes from area sources, such as dusty roads, timberland slash burns, and farmers' fields." What is substantial? What are the characteristics of this particulate, and what does it contribute to the particulate loadings at various points? How far does such particulate matter travel? This sentence is irrelevant, misleading, contains no information, and is exemplary of a classical breakdown in air pollution science.

R. Webster shows several definitions for "substantial." It is used in the EIS to indicate "considerable." The comment was applied to the summary section, where discussion is necessarily generalized. More detailed information on the contribution of area sources to particulate emission may be found on pages A-1 through A-4 of the draft EIS.

C. We believe the estimate (p.21) of annual particulate emissions from agricultural operations is low by at least two orders of magnitude. According to the Fifth Annual Report of the Montana Environmental Quality Council (1976), Montana has 16.6 million acres of cropland. Therefore, the EIS estimate of 20,000 tons per year indicates the emission rate would be only 2.4 pounds per acre. By contrast, the 1978 PEDCO report exposed areas may emit as much as 1200 lb/ac/year. If one-fourth of the total cropland acreage is fallow each year, the estimated emissions from wind erosion alone would be 2, 490,000 tons. It seems reasonable that total particulate emissions from agricultural activities are at least twice that much.

R. According to the PEDCo Environmental report, "Particulate and SO_2 Emission Inventory for non-AQMA Counties in Montana," (1976), the 200,000 ton figure cited in the EIS applied soley to wind blown dust from agricultural lands and not from agricultural activity such as tilling, as the EIS incorrectly said. The same report shows emissions for tillage activities for the state to be approximately 9,000 tons per year, bringing total agricultural particulate emissions to 29,000 tons. The PEDCo researchers used the following two formulae to estimate the two types of emission.

Wind Blown Dust

$$E = a \times I \times K \times C \times L' \times V'$$

where E = emission factor, ton/acre/yr
a = portion of total wind erosion losses that would be measured as particulates, estimated at 0.025
I = soil erodibility, ton/acre/yr
K = surface roughness factor
C = climatic factor
L' = unsheltered field width factor
V' = vegetative cover factor

Agricultural Tillings:

$$E = \frac{1.4s}{(PE/50)^2}$$

where E = emission factor, lb/acre
s = silt content of surface soil, percent
PE = Thornthwaite's precipitation-evaporation index

Input data to the equations was determined on a county by county basis considering: the number of acres of land planted to seven major corps, a map of major soil types, soil samples of major soil types, and a map of the precipitation-evaporation (PE) indices. It should be mentioned that some crops such as hay have almost no emissions from agricultural tillage or wind erosion.

C. A regional estimate of particulate emissions from coal mining should be included in the EIS, despite limitations in available data.

R. As stated in the EIS, the Department contends that "it is difficult to precisely determine emission levels from any given mine or to generalize the emission characteristics for mines of this type. Each mine has its own characteristic emission sources which are not necessarily duplicated in any other mine."

C. The airborne particulate study being conducted by the DOH and DHES should be mentioned in the EIS.

R. The report referred to regards the Development of Emission Standards for Paved and Unpaved Roads (DESPUR) which is scheduled to be conducted over a two year period by the Department of Environmental Sciences (DHES) and the Department of Highways (DOH). The major goal of DESPUR is to develop standards to ensure that areas designated nonattainment for either the primary or secondary EPA total suspended particulate standard will be brought into compliance within the time frame designated by the federal government. The draft interim DESPUR report has been completed, and the decision whether to continue the study has yet to be made.

C. Given the differences among coal mines, the EIS oversteps by saying <u>all</u> coal mines are a significant source of particulate emissions.

R. The exact quote from the EIS is "coal strip mines are a significant source of particulate emissions in eastern Montana." The sentence addresses coal strip mines as a group, not as individual mines. It is possible that some mines might have low emissions, but strip mines as a class are significant sources.

C. The EIS in its discussion of air pollution in Montana should include a list of potential sources.

R. The following table is from the Northern Powder River Basin EIS team. It is the best information available relating to future pollution sources in Montana.

PROJECTED ANNUAL COAL PRODUCTION
[Millions of tons per year]

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Existing mines												
Absaloka	5.3	7.3	7.3	7.3	7.8	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Big Sky	2.3	3.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Decker West	5.0	5.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
East	4.0	4.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Knife River	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Pearl	---	---	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Spring Creek	---	3.0	6.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
WECo Area A	7.4	6.1	2.6	2.8	4.2	4.9	4.9	4.9	4.9	4.9	2.8	0
Area B	1.6	2.1	6.5	7.2	5.5	4.8	4.8	4.8	4.8	4.8	6.9	9.7
Area E	3.9	3.8	3.8	3.8	3.8	1.9	0	0	0	0	0	0
Total---------	29.8	34.6	45.7	48.6	48.8	49.1	47.2	47.2	47.2	47.2	47.2	47.2
Planned mines												
Consolidation CX	---	---	---	---	---	---	4.0	6.0	6.0	8.0	8.0	8.0
Decker North	---	---	---	---	---	4.0	4.0	4.0	4.0	4.0	4.0	4.0
E. Sarpy Creek[1]	---	---	---	5.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Nance	---	---	---	---	1.0	4.0	7.0	10.0	12.0	12.0	12.0	12.0
WECo Area C[2]	0	0	0	0	1.4	4.2	5.6	5.6	5.6	5.6	5.6	5.6
Area D	0	0	0	0	0	1.9	3.8	3.8	3.8	3.8	3.8	3.8
WECo Pine Hills	---	---	---	---	---	2.0	3.5	3.5	3.5	3.5	3.5	3.5
Youngs Creek[1]	---	---	---	4.0	6.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0
Total----------	0	0	0	4.0	13.4	34.1	47.9	52.9	54.9	56.9	56.9	56.9
Possible mines												
Northern Resources	(would feed the Basin Electric plant in Circle)									1.5	2.5	2.5
Cook Mountain	---	---	---	---	---	---	---	---	3.0	6.0	10.0	10.0
Otter Creek	---	---	---	---	---	---	3.0	5.0	5.0	5.0	5.0	5.0
Tract II	(would probably not be developed in the near future unless the Absaloka mine were not to receive a needed permit)											
Total-----------	0	0	0	0	0	0	3.0	5.0	8.0	12.5	17.5	17.5
Grand total	29.8	34.6	45.7	52.6	62.2	83.2	98.1	105.1	110.1	116.6	121.6	121.6

Installed Electrical Capacity
[in Megawatts (MW)]

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Existing plants	940	940	940	940	940	940	940	940	940	940	940	940
Planned plants												
Colstrip 3 & 4	---	---	---	---	700	1400	1400	1400	1400	1400	1400	1400
Possible plants												
Bas Elec - Circle	---	---	---	---	---	---	---	---	---	500	500	500
MPC - Miles City	---	---	---	---	---	---	---	---	---	---	350	350

Syn-fuel plants
"Take a chance"

[1]Assumes the company acquires a lease in 1979.
[2]Assumes Colstrip unit 3 goes on line in 1984.

C. We agreee with the EIS that each strip mine has its own characteristic emissions, but we feel this prohibits the development of uniform standards for all mines.

R. It is unclear to the Department whether the commentator is speaking of ambient standards or emission standards. Since this document deals with ambient standards, it is assumed ambient standards are addressed. The proposed TSP standard would be uniform statewide in order to protect human health and the environment. It is difficult to generalize emission estimates on such sources, and control requirements probably will be developed on a case-by-case basis.

C. The EIS is deficient on page 25 where: (1) it does not identify the time period that the ambient data represents, (2) the 107 ug/m^3 is a geometric mean while the proposed standards is an arithmetic mean and (3) the paragraph suggests that the source of particulates is strip mining activity.

R. The Bureau agrees that the data should be clearly dated and presented as a geometric mean. Furthermore, the Bureau agrees that most of the particulates being sampled at this site may not be from mining activity but may be related to unpaved roads and construction activity within the town of Colstrip.

C. The EIS should have included a table showing particle sizing distribution in the ambient air of Montana.

R. The Bureau agrees that more knowledge on particle size and distribution would be beneficial. However, monitoring of particulate by size has only recenty begun and little information has been generated. To date this information shows Montana does not have a typical size distribution. There is considerable variation among cities as well as seasonal variations at different sites. The Bureau believes it is too early to formulate a typical Montana particle size distribution.

C. The discussions of the potential toxic effects of coal dust on vegetation presents no information as to whether the chemical or physical properties of coal dust are directly injurious to plants. If any of these properties are toxic, then comparison should be made between the different varieties of coal dust found in Montana. The comparison should include discussion of the types of vegetation likely to be affected.

R. Toxic effects of coal dust on vegetation generally have been attributed to its physical interference with plant functions, such as clogging leaf pores used for respiration and photosynthesis, or by reducing fruit set by preventing pollen germination. In this sense coal dust is probably no different than other types of particulates.

It is possible that the chemical nature of the particulate may affect vegetation adversely, as has been shown for some alkaline particulates. The effects on vegetation from different coal dusts with different chemical properties have not been evaluated to date.

C. Is there any information regarding effects of airborne particulate composed of soil particles on livestock or other animals? If so, it should be included.

R. There has been no information concerning soil-generated airborne particulate on livestock or other animals, to our knowledge.

C. The table on page 24 of the draft EIS regarding coal mine particulate emissions is incorrect. The data shown for the Western Energy mine is erroneous, in that there was no mining in Area A until April of 1975. Furthermore, PEDCo Environmental Inc., decided not to use this data in it's final report entitled "Survey of Fugitive Dust from Coal Mines," February, 1978, EPA-908/1-78-003, because the accuracy of the data was in question.

R. Correct. In the future the Department will rely on the 1978 report.

C. The EIS is deficient in not saying (p. 39) that Stauffer has completely abated all fluoride sources within its plant. The slag pit abatement project was recently completed and if successful will completely abate fluride emissions from the pits. Stauffer's abatement efforts then will have reduced fluoride emissions from the entire plant from approximately 6,450 lbs/day to less than 125 lbs/day better than a 98% control of fluoride emissions. The equipment installed to achieve such control represents the best available control technology.

R. The Department disagrees that the total amount of fluoride emitted can currently be accurately quantified. The hoods over the tap holes are not capturing all the fluorides which are supposed to be sent to the hydroprecipitrol, which in turn is less than 100% efficient. Therefore, the furnace area emissions cannot be said to be completely controlled.

C. The EIS is wrong in suggesting (p. 31) that only 50 percent of the Stauffer fluoride emissions have been abated. Actually, prior to the recent beginning of slag pit abatement, 93% of the fluoride generated in the plant was captured.

R. The base year for determining fluoride emissions was 1977 and, as of that time, Stauffer had abated approximately 50% of its 1976 uncontrolled fluoride emissions. The Department agrees, however, that control of fluorides at

the plant probably is greater than 90%. The statement in the EIS that control measures in the process of installation would bring Stauffer's abatement of fluoride up to 75% also refers to those same 1976 uncontrolled fluoride emissions which were quantified at 615 lbs/day. Control as of April 1979 was approximately 150 pounds per day (Department estimated).

C. Data on ambient fluoride concentrations gathered by Stauffer Chemical Company indicate that Stauffer violations of the 30-day and 5-month growing season standards will occur, even though the company fully complies with the 24-hour standard.

R. A Department review of air quaity data in the vicinity of the plant indicates that the plant will meet the proposed 24-hour standard. Air quality data also strongly suggests that the proposed 30-day standard will be achieved once the current control program is fully operational. The growing season standard proposed in the draft EIS has been eliminated from the Department's final proposal.

C. The particulate emissions listed (p. 31) for Westmoreland in Table A-I assume year-round operation. Since the boilers operate only in the winter, this figure should be cut in half.

R. Correct.

C. The EIS said (p. 44) that Montana Sulphur was planning to raise its stack to 200 feet. Actually it has indicated its willingness to raise it to 100 meters.

R. Correct.

C. More details are needed on the sources of pollution in Montana, their meteorological and topographical relationships and their unique features.

R. Such information would be nice to have, but probably would not affect the standards proposed since they are primarily designed to protect the public health regardless of the meteorological conditions near any single source.

C. Would it not be useful to include a table showing the relative contribution of each class of sources to pollutant emissions. For example, industry causes only 4.4 percent of particulate loadings.

R. Such a table would not be useful. The relative contributions from each major source vary from year to year, season to season, month to month. Industry might be responsible for only 10% of some given pollutant (yearly

average) but be responsible for 60% of the same pollutant during periods of intense inversions (i.e. periods of most concern). The opposite, of course, could also be true. The simplification provided by such a table would be misleading without a detailed discussion.

C. The DEIS says (p. 49) that sulfur dioxide and particulate levels recorded in Montana only occasionally exceed levels known to have health effects. This is inaccurate since pollution levels in the Billings-Laurel area alone are known to frequently violate the federal standards.

R. It is correct that the data indicate that violations occur more than "occasionally" in Laurel. The "occasionally" as used in the EIS referred to the levels in the whole state, to indicate that violations occurred in only a few places.

C. The EIS is not correct (p. 49) in saying that a 0.10 ppm 24-hour sulfur dioxide average is typical of Montana.

R. While there are some places in Montana that have much lower concentrations of sulfur dioxide almost all the time, there are others where the 0.10 ppm 24-hour average occurs several times a year. Sulfur dioxide levels in Montana are highly variable from place to place.

C. The draft EIS said Anaconda Aluminum is expected to meet the proposed ambient standard with equipment now scheduled for installation. The Department has no basis for this assertion.

R. Detailed computer tabulations of all previous ambient data collected near the Anaconda Aluminum plant along with the projected emission level of the plant after completion of the present pollution abatement program indicate the statement in the draft EIS was correct.

C. In reference to the weak night time inversions experienced at Colstrip, as mentioned in the EIS (p. 46), it should be noted that the stacks of Colstrip 1 & 2 and the proposed stacks for Colstrip 3 & 4 would provide sufficient height and velocity to put the plumes above the ground based inversions.

R. The comment is correct when the inversions in question are the ground based type formed by radiational cooling. The stacks will not be sufficient when the inversions are of the subsidence type, caused by slowly sinking air from stagnent high pressure systems. When inversions of this type are present there may be an accumulation of pollutants.

C. Why are there six sources of sulfur dioxide for which the degree of control is unknown?

R. The reason is that the sulfur dioxide sources thought to have the most significant emission are stack tested to determine the seriousness of the problem. Sources with negligible sulfur dioxide emission may be tested eventually, but for the time being the emphasis is on sources with significant or potentially significant emissions.

C. Has the AQB not presented all the ambient monitoring data from the Anaconda sites? Does presentation of only Hiway Junction data serve to deceive the public regarding the proposed .02 annual sulfur dioxide standard?

R. The table on page A-15 shows only the values from the recording stations with generally higher readings. Data from other sites could be provided, but would require a much longer table. The highest recording station generally defines the seriousness of the problem that must be dealt with in the vicinity of a source.

C. The EIS estimates (p. 31) of particulate and sulfur dioxide emissions for Colstrip 1 and 2 were wrong. A recent EPA draft report showed sulfur removal efficiency at the plants was 83.5 percent, which would indicate that 1977 emissions of sulfur dioxide would have been 5290 tons. Particulate emissions from the two units in 1977 were 710 tons, based on all the source test data available as of the date of this comment (early 1979).

R. The commentator is correct that the figures shown in the draft EIS were slightly amiss. The error was small and probably without significance. It resulted from the use of data from only the first 13 of the 14 source tests performed in 1977. The commentator injected the possibility of more considerable error by including 1978 data in the estimate of 1977 emissions. Review of all the 1977 source tests shows emissions for that year to have been as follows: sulfur dioxide, 5586 tons; particulate, 752 tons.

C. The EIS said that the alkaline scrubbing medium used at the Colstrip 1 and 2 power plants provides sulfur dioxide removal of approximately 75 percent. This 75 percent figure does not agree with the findings of Pacific Environmental Services, Inc. made under EPA contract 68-01-7140, which show average sulfur dioxide removal at 83.5 percent based on actual test data.

R. The 75 percent figure is an annual average estimate while the 83.5 percent figure is an estimate based on a single study which included the sulfur removed by pyritic sulfur rejection in it's calculation. Currently, the Department believes the 75 percent estimate to be more accurate in assessing a yearly average.

C. The discussion in the draft EIS of the Colstrip vicinity does not include any reference to emissions from the Colstrip 3 and 4 power plants which are soon to be built there.

R. The Colstrip 3 power plant is expected to be operational by 1983 and the Colstrip 4 plant by 1984. Combined emissions from both plants operating with pollution control equipment are estimated at 2,582 tons/year of particulate and 6,634 tons/year of sulfur dioxide. Modeling indicates that the units will meet prevention of significant deterioration (PSD) increments and both the federal and the proposed Montana ambient air quality standards.

C. The EIS said Hoerner-Waldorf appeared to be in compliance with the proposed hydrogen sulfide standard. Are they or are they not in compliance?

R. Data for July of 1978 and 1979 from three monitoring sites located near Hoerner Waldorf show there were a significant number of one-hour average concentrations in excess of 0.04 ppm. One measurement was above 0.06 ppm in 1979 and five in 1978. Many of these high measurements were in all likelihood associated with wastewater treatment ponds. The Department expects the facility to comply with the proposed 0.05 ppm standard.

C. The EIS said (p. 32) Hoerner-Waldorf is the only source in Missoula likely to be affected by the adoption of the proposed particulate standards. Is it not likely that this is wrong, considering that the TSP standards would be exceeded in Missoula?

R. The Bureau agrees the statement may be misleading. Reduction of total suspended particulates would have to be achieved through controls on various point and area sources. It is hoped that improved control of road dust will reduce particulate concentrations enough to comply with standards.

C. If the hydrogen sulfide ambient standard is weakened, Hoerner-Waldorf will increase its hydrogen sulfide emissions causing an increased odor problem in Missoula.

R. The amount of hydrogen sulfide Hoerner Waldorf is allowed to emit is limited by its operating permit. Therefore weakening the hydrogen sulfide ambient standard would not affect Hoerner Waldorf hydrogen sulfide emissions.

C. Information concerning trace metals in vegetable gardens in the vicinity (2-5 miles) of the ASARCO and Anaconda smelters, if available, should be presented in full.

R. Vegetation Metal Analysis - Anaconda and East Helena

1. West central location in Anaconda (900 block west, 5th St.) Samples taken in late July 1976 from garden analyzed and reported by State Health Dept. lab in November 4, 1976. Samples unwashed prior to analysis.

Sample Description	Cadmium	Arsenic	Lead	Selenium
Beet greens	19 ppm	45.5 ppm	10.4 ppm	0 ppm
Tomatoes	0.5	0.7	5.0	0
Peas	0.2	2.1	5.0	0
Beets	3.7	14.2	9.0	0
Subsoil (9" depth)	2.5	275	140	1.2
Topsoil (1" depth)	1.0	137	60	1.2

2. Analysis of above samples as taken from freezer in washed state. Reported by State lab Nov. 14, 1977.

Sample Description	Cadmium	Arsenic	Lead	Selenium
Beet greens	13 ppm	2.3 ppm	9.0 ppm	0
Kohlrabi	0	0	0.6	0
Carrots	1.1	1.1	1.0	0
Beets	2.5	1.7	0.7	0
Tuber vegetable	0.5	9.4	0.7	0

3. Garden samples taken in July 1978 at the same garden plot listed in 1 and 2 above plus an adjacent plot. Samples washed prior to analysis.

Sample Description	Cadmium	Arsenic	Lead	Selenium
Kohlrabi	0.6 ppm	0.45 ppm	6 ppm	0.12 ppm
Beets	2.8	0.75	5	0.05
Broccoli	0.6	0.75	5	0.10
Peas	0.6	0.50	5	0.05
Adjacent garden				
Potatoes	0.6	0.25	15	0.05
Beets	0.6	1.50	5	0.05
Spinach	1.2	1.6	5	0.05

4. East Helena garden in NE area of town - Samples taken in June 1979.

Sample Description	Cadmium	Arsenic	Lead
Unwashed lettuce	30 ppm	13.7 ppm	72 ppm
Washed lettuce	24	7.6	40

Additional data on heavy metal accumulation in garden vegetables near East Helena for 1969 are presented in an EPA (1972) publication.

GENERAL COMMENTS ON SULFUR DIOXIDE AND PARTICULATES

C. The proposed allowance of only one exceedance a year is too stringent. The old Montana standard permitted one hour exceedances of 0.25 ppm once every four consecutive days.

R. Because meteorological conditions vary from place to place, it is not possible to make a strict comparison between the existing rule and the proposed standards. However, with reasonable estimates of the range of meteorological conditions in Montana, the existing rule is estimated to be equivalent to a standard of approximately 0.8 to 1.60 ppm when one exceedance a year is allowed.

C. No rationale is given for selecting one hour as the appropriate exposure period, rather than 30 minutes, two hours, or some other time.

R. It was decided to standardize all short-term standards to one hour. Time less than this may be difficult to establish as a reasonable averaging period for enforcement. Times longer than this would allow the possibility of a significantly higher peak value over 15 to 30 minues.

C. The synergistic effects of the various air pollutants occurring together in the ambient air were not considered in establishing the standard for sulfur dioxide.

R. Most of the studies considered in support of the sulfur dioxide standard examined situations where both sulfur oxides and particulates were present. By relying on these studies, the synergistic effects are given full consideration.

C. The working papers reported that of the 20 counties with the highest sulfur dioxide readings in the nation, three were in Montana. This was left out of the EIS.

R. The statement was true for 1976. Since then sulfur dioxide control programs have been initiated at ASARCO and Anaconda Copper. Later information is not available on the relative ranking of U.S. counties, so it is not known if Montana still hosts some of the worst pollution conditions in the nation.

C. What is the source of the information on conversion rate of sulfur dioxide to sulfate?

R. For a further discussion see Freiberg (1978) and references cited therein.

Nowhere in the EIS is it demonstrated that sulfur dioxide and several other pollutants known to act synergistically are found in Montana in concentrations sufficient to generate synergistic reactions. It is therefore meaningless to include an analysis of these pollutant interactions in determining an adequate standard for sulfur dioxide.

The draft EIS took the position that experiments on combined pollutants would be discussed when the levels of the individual pollutants were equal to or less than the respective federal air quality standards. As shown in Appendix A of the draft EIS, elevated levels of various pollutants do exist in Montana. Even in areas where both pollutants do not now occur future economic development may introduce one or the other in significant quantities.

The State of California, in setting its standard for sulfur dioxide, considered the expected future emissions of sulfur dioxide from the use of coal in producing electricity. Moreover, California recognized that one function of a sulfur dioxide standard is to serve as a partial control of ambient levels of suspended sulfates, sulfuric acid mist, and acid precipitation, which have no standards of their own.

It is appropriate to consider the relationship between a given sulfur dioxide standard and ambient levels of suspended sulfates, acid mists, and acid precipitation when developing a sulfur dioxide standard if data are available to establish a quantative relationship. The necessary information is not available for Montana so such an analysis was not possible in developing a Montana standard. Therefore, the concern over these factors was not weighed in developing a margin of safety for sulfur dioxide.

Many particulate sources, such as coal strip mines, do not have high accompanying sulfur oxide levels. The EIS should discuss studies where no sulfur oxides are present.

The only substantial studies performed where sulfur oxides were negligible were the Birmingham Charlotte EPA studies discussed on pages 66-68.

There is no evidence presented that there are fine particles present in any significant magnitude in Montana.

There is some evidence to suggest that there is a significant percentage of fine particles in Montana. The Montana Air Pollution Study has been carrying out extensive fine particulate measurements for about 18 months. Initial results for the first eight months of operation suggests that between 55% and 75% of all the particulate mass collected on the high volume sampler is less than 15 microns. These data are from all the major Montana cities. The findings are particularly interesting since the high volume sampler is thought to be biased to the larger particles. A high correlation coefficient

(larger than 0.8) was found in six of the eight sites between the high volume sampler and fine particulates. Therefore, the suggestion that there are no fine particulates of significant magnitude is incorrect.

C. The TSP standard is not valid because the high volume sampler passes a large fraction of fine (respirable) particles through the filter.

R. This statement is not correct. The filters used by the high volume sampler are subjected to testing before being used. One of the requirements of the test is that the filter must be able to collect at least 99% of all 0.3 micron particles (called the DOP test). The "reference" method for measuring TSP as described by the Environmental Protection Agency (Title 40 § 50.11 Appendix B) states that the method generally measures particles as small as 0.1 micron. Particles below 0.1 microns tend to act as a gas and can pass freely in and out of the lungs.

C. Since the Bureau does not use and is not likely to use the proposed pararosaniline method for sulfur dioxide, what methods are being considered as equivalent?

R. The Bureau is considering the following equivalent methods for monitoring sulfur dioxide:
   a. Flame Photometric (Meloy Model SA185-2A and model SA285E, Bendix Model 8303, Monitor Labs 8450).
   b. Pulsed Fluorescence (Thermo Electron Model 43, Beckman Model 953).
   c. Coulometric (Phillips Model PW9755 and PW9700).
   d. Conductometric (ASARCO Model 500).

The Bureau thinks the above methods are superior to the pararosanoline method because of their response time and selectivity. The pararosanoline method however, is generally less expensive to operate over a short period of time.

C. How will the Bureau be sure that the conversion between ppm and ug/m^3 is consistent for sulfur dioxide and other pollutants?

R. The EIS says that all concentrations must be reported in reference to 25^{o}C and 760 mm of mercury. This insures consistency in the conversion. Any measurement of sulfur dioxide or other gas pollutant must be referenced to these conditions.

C. What sulfur dioxide instruments are most likely to be used in the Montana City area?

R. The Bureau probably will use a pulsed fluorescence analyzer while the ASARCO Company will use the conductometric instrument. Both instruments have undergone rigorous testing to assure that they are equally sensitive to sulfur dioxide.

C. Several of the epidemiological studies of the correlation between daily occurrences of sickness or death and sulfur dioxide levels found that an apparent association disappeared when daily variations in temperature were taken into account.

R. Statistical studies must be very careful to take all relevant variables into account when attempting to analyze air pollution and health data. Other factors besides temperature also can affect the sickness and death rates, such as influenza epidemics or birthdays and holidays. Corrections for temperature variations can be a double-edged sword. Because of the sulfur in heating oils, sulfur concentrations tend to increase in the winter and are thus co-linear to temperature. Weather patterns that cause buildups in pollution also have characteristic patterns of temperature variation. Including a temperature variable often results, rightly or wrongly, in attributing the association between illness and pollution to temperature changes. Most of the studies reported in the draft EIS utilized corrections for temperature, some more sophsticated than others.

C. Sulfur oxides are naturally occurring substances. The human race evolved while breathing them and has nothing to fear at current exposures in Montana.

R. This is sheer fantasy. While there is some evidence that the evolution of homo sapiens in the presence of moderate, recurring levels of natural ozone has resulted in some natural defense mechanisms against that pollutant there is no evidence that the existing natural defense mechanisms against sulfates (ammonia production in the mouth and biochemically reactive substances in the body) are at all related to an evolutionary response to sulfur dioxide. The only significant source of natural sulfur is volcanism. The great age of volcanism with its high sulfur dioxide levels had ceased long before the evolutionary surge of the human species to its present place of dominance. Natural sources of sulfur dioxide have been measured to be less than 0.2 grams of sulfur per square meter per year in the eastern U. S. (Adams et al,1978). This means that natural sulfur contributes less than two percent of all the sulfur in the atmosphere in the eastern U. S. It is as reasonable to assume that, because humans evolved without sulfur dioxide in the atmosphere in any significant quantities, there is no threshhold for adverse health effects because no protective mechanism specific to this challenge ever had to be developed.

C. The brief discussion of sulfur dioxide and cancer (p. 56) may suggest to some people that sulfur dioixde is a cause of cancer. The AQB should make clear that many scientists do not believe that there is any link between sulfur dioxide and cancer.

R. In each of the studies cited in the draft EIS, sulfur dioxide was administered to laboratory animals along with a known cancer-causing agent. The sulfur dioxide increased the incidence of cancer. Some studies of smelter workers suggest sulfur dioxide may enhance the chances for cancer, but

there is no evidence that sulfur dioxide is itself a cause of cancer. Some scientists even doubt that sulfur dioxide plays a very significant role as a promoter.

C. The Newman et al. (1975) study on cancers in smelting communities is relevant to the discussion of sulfur dioxide. It is not specific to arsenic as indicated in the draft EIS.

R. While there is some evidence that sulfur dioxide may facilitate the onset of cancer in some circumstances, there is no evidence that sulfur dioxide is itself a cause of cancer. The Newman et al. paper does not add to that understanding. It is important in demonstrating an increased cancer rate among persons exposed to the effluents of a smelter. These pollutants include other chemicals besides sulfur dioxide that have been shown to cause cancer in humans.

C. The two Amdur studies cited p. 55-56 are not relevant to the setting of a particulate standard.

R. These studies were cited only to illustrate two particulate substances that cause adverse health effects, at least in animals. They also illustrate that a chemical may have a greater effect as a particle than as a gas.

C. The EIS (p. 56) should have made clear that the Asmundson study on the combined effects of sulfur dioxide and particulate used concentrations of 200 to 400 ppm sulfur dioxide and 740 ug/m^3 carbon dust. These are extraordinarily high concentrations of the pollutants.

R. The sentence referred to was not intended to establish any concentrations but only to illustrate the synergism between sulfur dioxide and particulate and the type of cell injury resulting. Although it is not as well established, it is often assumed that similar synergistic effects occur at lower concentrations. Some scientists suggest that such effects occur only at the higher concentrations. In view of these differing opinions, the concentration is relevant and should have been reported.

C. A dose and exposure time are necessary to properly evaluate the comment (p. 57) on bacterial infection as related to sulfur dioxide and inert particle combined exposure (Rylander et al. 1971).

R. This comment was not intended to define an effect but only to illustrate a mechanism. To quote additional details would give the study more emphasis than was intended.

C. Alarie et al. (1970, 1972, 1973, 1975) and several other researchers have exposed guinea pigs, monkeys, dogs, donkeys and various other animals to

sulfur dioxide at concentrations from 1 to 10 ppm for long periods of time, from two months to two years, without observing any adverse effects.

R. Numerous experiments have failed to observe significant chronic effects in laboratory animals exposed to sulfur dioxide at the concentrations mentioned. There is evidence that an acclimatization to sulfur dioxide occurs in 80 to 90 percent of the human population, although "the adjustment is not considered to be a beneficial effect" (NIOSH, 1974). It is reasonable to assume that a similar adjustment occurs in the animals studied. Other studies that measured physiological variables not subject to the acclimatization response have observed chronic effects, including depression of immunological systems and changes in hemoglobin content of the blood. Hirsch et al. (1975) observed an impairment of mucocilliary activity with a chronic exposure to 1 ppm of sulfur dioxide. This would decrease the ability of the animal to clear bacteria from the lung. Although Alarie et al. (1975) did not observe any chronic effects from sulfur dioxide alone, they did observe significant changes in the lung function of the animals when sulfuric acid particulate was added to the intake air.

C. The discussion (p. 58) of short-term exposures to sulfur dioxide leaves the impression that these might result in permanent damage, while in fact they appear to cause only temporary reactions that have no long-term health consequences.

R. Although effects have been seen by several researchers at 1 ppm sulfur dioxide, others (Burton et al. 1969, Frank et al. 1974) reported an apparent acclimatization to sulfur dioxide exposures which is believed to come from the suppression of tracheo-bronchial nerve responses. It is not so clear cut. While the reactions are of no immediate health consequence in otherwise healthy people and are apparently reversible after the exposure is withdrawn they are of substantial health consequence to a person with already impaired lung function. Changes in mucous flow rates indicate an impairment of the lung's ability to defend itself against a bacterial infection.

C. The EIS is incorrect (p. 58) that Snell and Luchsinger found "significant lung function impairment following exposure to 1 ppm of sulfur dioxide for 15 minutes."

R. The sentence should have read "statistically significant decrease in lung function following exposure . . . ."

C. Snell and Luchsinger (1969) (p. 58) exposed their subjects by having them breathe through the mouth. Most people don't breathe that way.

R. A significant fraction of the population breathes through the mouth habitually or by necessity.

C. The age and health status of the subjects is needed to properly evaluate the meaning of these (p. 58) studies on the effects of sulfur dioxide.

R. Nadel *et al*. (1965): Seven healthy subjects between 27 and 40 years old of unstated sex.

Lawther *et al*. (1975): Thirteen to seventeen normal healthy subjects between 18 and 47 years of both sexes. Most were nonsmokers.

Frank (1962): Eleven to fourteen healthy males (four had had a respiratory illness one to thirty years previously); five smokers between 22 and 56 years old.

Florida Sulfur Oxides Study (1978): Forty asthma patients and 40 "normals." Twenty of the 80 were contacted to determine if there were delayed adverse effects.

Snell and Luchsinger (1969): Five healthy males and four healthy females between 20 and 40 years old.

Bates and Hauzucha (1973): Four healthy young men.

Most of this information was available in Table III.A-II.

C. The Bates and Hazucha study (p. 58) is of questionable value since the number of subjects was so small.

R. The study involved only four individuals. However, the effect began to be observed within 30 minutes and recovery occurred when the exposure was terminated.

C. The EIS is incorrect (p. 58) that the three subjects in the Florida Sulfur Oxides Study experiment suffered "mild asthma attacks." The phrase used in a later paper describing this study is "some wheezing." A group of 40 asthmatics did not respond in any marked way to the exposure to 0.5 ppm sulfur dioxide.

R. First, not all the subjects had pre-existing asthma. In fact, one who exhibited a substantial response to the exposure was not an asthma patient. He was the son of one of the researchers conducting the experiment. It is interesting to note that his father refused to allow him to be subjected to the exposure a second time as a check on the effect. It would be more correct to refer to the reaction as "asthmatic symptoms." A sensitive test found a three percent reduction of lung function among the asthma patients after exposure to the sulfur dioxide.

C. Jaeger et al. (in press) concludes that 0.5 ppm sulfur dioxide is close to a threshold for asthmatics. A standard at that level should be sufficient.

R. The Jaeger et al. paper has not yet appeared in the journal you referred to and is not available for review by the Air Quality Bureau. Jaeger and other participants in the medical panel of the Florida Sulfur Oxides Study recommended retaining the existing sulfur dioxide standard of 0.5 ppm for three hours, saying that there was not sufficient evidence to justify either tightening or relaxing it.

C. The effects noticed by Andersen et al. (1974) and cited in the EIS (p. 59) are probably of minimal significance to the public health. The reduction in mucuous flow was not statistically significant at one ppm and the mean discomfort rate was small for all exposures.

R. While it is true that the effects were reversible and may not have any long term consequences, it cannot be said that the Andersen et al. results are of no significance. Although the reduced mucuous flow was not statistically significant for the group as a whole, the Bureau focused upon the sensitive individuals within the group. For them, the change was small but definitely observable. In addition, the magnitude of the discomfort rate was an average figure. Some of the subjects experienced no discomfort. Others registered significant discomfort.

C. The mean discomfort rate in the Anderson et al. study was small for all exposures.

R. Again, you are looking only at the average of all the subjects. Some of them never experienced any discomfort. Others registered significant discomfort.

C. What was the exposure time for the Andersen et al. subjects (p. 59)?

R. Six hours.

C. The draft EIS fails to report on the work of Hackney et al. (1978) and Sackner et al.(1977) that does not indicate any effect of sulfates or sulfuric acid particles at concentrations significantly greater than those observed in the ambient air.

R. In abstracts of these unpublished papers, Sackner and Rinehart (1977) and Sackner et al.(1976, 1977) describe no effect on mucocilliary activity in sheep exposed to various sulfate aerosols (of unspecified size) at 340 to 950 ug/m^3 for 20 minutes, and no effect on lung function. Sulfuric acid

particles and six sulfates of unspecified diameter were administered to dogs and normal human subjects for 10 minutes at 1000 ug/m^3. The Hackney et al.(1978) paper is a review of experiments with sulfuric acid and sulfate particles on human subjects. No data is presented in the paper, but it appears to be the same study reported by Avol et al. (1978) that was discussed briefly in an earlier MAAQS working paper. No effects were observed in these tests, but errors in experimental design may have made it impossible for the researchers to observe any effects.

C. The draft EIS should have cited Kreisman et al. (1976), who found only a slight change in lung function with exposure to 3 to 5 ppm of sulfur dioxide and an inconsistent effect at 1 ppm. These are short-lasting, reversible effects rather than permanent damage.

R. Kreisman et al. (1976) exposed their subjects for less than five minutes. The changes observed were statistically significant.

The long-term impact of an event which temporarily decreases lung function is not known. As people age, they normally lose lung function. Thus an average sedentary male of 40 will have only 89 percent of the lung function he had at age 25. This is approximately equal to the temporary loss observed in the cited laboratory tests with sulfur dioxide. The disease syndrome that eventually results in a chronic obstructive lung condition is marked by a more rapid loss of lung function in those who eventually develop shortness of breath or repeated lung infections. Thus at age 40 a man with initial chronic bronchitis or similar condition may have 93 percent of the lung function of his healthy counterpart, but at age 55 retain only 79 percent of the lung function of a normal 55 year old man. There is no clear dividing line marking the onset of clinical disease but rather a gradual increase in absenteeism, disability and poor health.

The lung function loss in an individual is a function of the sum of past permanent losses and continuing present respiratory insults. The importance of a previous temporary loss which was fully recovered at the time is unknown, but does not appear to contribute substantially to the rate of permanent loss of lung function. This progression into chronic obstructive lung disease has been demonstrated most clearly by Fletcher et al. (1976) for cigarette smoking. It has been shown that other insults to the lung, such as occupational exposures, air pollution and adverse weather will accentuate the effects of cigarette smoking and may have similar but smaller effects in nonsmokers.

Many of the effects of lung function loss due to air pollution have been observed in individuals whose lung function is already impaired. For these individuals an additional loss of 10 to 20 percent of lung function could significantly inhibit activity and could require hospitalization in some instances. Most of the deaths that have been reported as associated with air pollution episodes were of such persons.

C. The draft EIS failed to consider the studies of sulfur dioxide effects reported by Hackney et al. (1975).

R. The study cited was discussed on pp. 162-3 with regard to the effects of ozone. The study did not involve sulfur dioxide or particulates in any way.

C. In light of the studies presented in the EIS and several others reviewed, there can be no questioning the conclusion that 1 ppm sulfur dioxide is sufficient to cause some pulmonary impairment and discomfort. However, the selection of 0.75 as a threshold is not equally justified. Further, the effects observed are of minimal health significance. They are transitory and fully reversible. There also is some evidence that no effects are seen when subjects are exposed to 0.3 to 0.4 ppm sulfur dioxide, even for extended periods. Based on this we believe a one-hour standard of 0.4 ppm is not necessary to protect the public health. We would recommend a one-hour standard of 0.7 ppm or a three-hour standard of 0.5 ppm.

R. Some of the experiments that have observed effects at 1 ppm were conducted at exposure times as short as ten minutes, or even 25 deep breaths. Further, these experiments usually involved healthy young men. It is not clear what might be observed if it were possible to carry out testing on a more sensitive segment of the population. Thus the apparent threshold between 0.75 ppm and 1 ppm must be tempered by the understanding that it might be lower for sensitive subjects.

The knowledge that the critical exposure time may be less than one hour and that the critical concentration may be less than 1 ppm for sensitive individuals suggests to the Department that the standard must be substantially less than 1 ppm if the observed effects are to be prevented.

The effects observed are a sensitive test of reaction to sulfur dioxide. Some of the changes relate to the rate of mucous flow in the throat and lungs. This suggests the initial stages of a reduction in the ability of the lung to clear itself of bacterial infections. Other changes are an increase in the resistance of the airways of the lung and a decrease in the volume of exhaled air. While these symptoms of lung malfunction are reversible and are not themselves of substantial concern, they are assumed to be warning signals of potentially more serious problems if the exposure is increased or repeated or if a more sensitive subject were exposed. Although the reactions observed in these short-term exposures do not cause the same concern as epidemiological evidence of increased rates of illness or death, they are of sufficient concern that they should be protected against.

A one-hour standard of 0.7 ppm probably would satisfactorily protect healthy young men from experiencing the adverse effects observed in these studies under most circumstances. There is a reasonable chance that even at this level the concentrations may exceed 1 ppm for a sufficiently long part of the hour for the observed effects to occur, so no margin of safety can be claimed at this level. If it is desired to protect a broader segment of the population than healthy young men, then it will be necessary to set a more stringent standard.

A three-hour standard, even at the more stringent limit of 0.5 ppm, has the same deficiency. For example, under the inversion breakup fumigation condition, the air quality will deteriorate from a level more or less at background to a high level in a few minutes. Depending on local conditions and the breadth of the saturated air layer, the high readings may persist for 15 minutes to an hour. They will then begin to decline at an approximately exponential rate. If it is assumed the peak level remains for 20 minutes, then a three hour 0.5 ppm standard would permit a peak value in excess of 1.4 ppm. To protect the public from exposures above 1.0 ppm for the critical periods of 15 to 30 minutes it is necessary to use a relatively short averaging time. One hour was chosen, rather than a shorter period, to be consistent with all the other ambient standards.

C. It is entirely possible that the effects of sulfur dioxide at low concentrations depends on the concurrent presence of particulate matter. It is significant that effects are often not observed in British studies where sulfur dioxide levels are high but particulate is low. Several recent reviews have suggested that the critical thresholds for health effects are 0.09 to 0.10 ppm sulfur dioxide together with 400 to 500 ug/m^3 suspended particulate.

R. It has been suggested that a standard composed of an index of sulfur dioxide and fine particulate should be considered. There is evidence that such a standard would reflect the experience of health effects research. However, there is insufficient data available at this time to construct and verify such an index. In the interim, separate standards for each pollutant are proposed.

C. The qualification (p. 61) that Lawther (1963) noted mortality only with sulfur dioxide "in the presence of particulates" does not fully convey the impact of the original statement which referred to particulate concentrations of 750 ug/m^3 BS. This is an extremely high concentration.

R. The effort to focus on the particular pollutant under consideration may have misled the reader by underemphasizing the particulate levels. MAAQS regrets any misunderstanding that may have occurred.

C. The EIS (p. 61) should clarify that the cited study by Lawther (1963) is not an analysis of original data but rather a re-analysis and summary of data collected by others. The paper does not present the details of his analysis and, thus, cannot be verified. There appears to be a typographical error in the quantity of particulate cited. It should be 750 ug/m^3 rather than 500 ug/m^3.

R. The Lawther analysis is quite convincing and widely quoted. The 500 ug/m^3 was in error; the correct figure is 750 ug/m^3.

C. Other researchers have refuted the analysis by Riggan _et al._ (p. 61) (1976) suggesting 14 deaths could be attributed to the 1975 Pittsburg episode. The EIS further fails to mention that when Stebbings _et al._ (1976) examined school children following the episode they found no significant alteration in lung function.

R. We have been unable to locate the studied referred to by the commentator. Since the Riggan _et al._ paper relied on a statistical model to establish that excess deaths occurred, it would not be surprising if a different model were to make a different prediction. The Stebbings _et al._ paper was cited only to indicate the source of the pollutant concentrations reported in conjunction with the Riggan _et al._ study.

Although the first report of the Stebbings _et al._ study indicated there was no evidence of adverse effect on lung function, a second and more careful analysis of their data demonstrated an adverse effect attributed to the episode. If the episode adversely affected the school children, then it would be expected that a gradual return to normal would be observed over the following week. On examining the data for individual children, Stebbings and Fogleman (1979) observed just such an effect for a sensitive minority of the children. They conclude, "episode levels of total suspended particulates may impair lung function in 10-15 percent of primary school children. A temporary reduction of about 20 percent in Forced Vital Capacity, requiring several days for recovery, may occur in susceptible subjects."

C. The mention of the London smog episode that occurred with sulfur dioxide levels of only 1.3 ppm does not emphasize the high levels of particulate that also occurred.

R. The EIS says the average particulate reading was 4500 ug/m^3. This is more than twenty times the proposed standard.

C. Buechley's study (1973) (p. 62) regarding the health effects of sulfur dioxide has been superceded by his 1975 follow-up study.

R. His 1975 report remains unpublished. He described it briefly in a short presentation at the New York Academy of Medicine meeting (Buechley 1978). Although sulfur dioxide and particulate are listed as "weak variables" in prediding death rates, nevertheless his research continues to find that the pollutants contribute to premature death.

C. The study by Douglas and Waller (1966) (p. 64) may be reporting health effects due to chronic exposures over many years when pollution levels were much higher than at present. Therefore, it is not correct to compare the observed effects to the recorded values of pollutants in a single year, especially if the pollution levels had been falling dramatically over the past few years.

R. The air pollution exposures of the children in this study were determined both by ambient measurements in 1962-63 and by emission inventories in 1951-52, when the children were five to six years old. The two indices of exposure were consistent. While there is merit to the comment that the exposures may be understated by the cited concentrations, it is doubtful whether the understatement is substantial.

C. The Wicken and Buck (1964) study reports air pollution measures taken in 1963-64 and compares these to death rates over the period 1952 to 1962. It is wrong to suggest that the observed differences in death rates can be associated with these air quality measurements made at the end of this ten-year period. The difference in the sulfur dioxide levels is so slight that the studies can only be interpreted with respect to the particulate concentrations.

R. Particulate levels began declining in England in the mid-50s. However, sulfur dioxide levels remained fairly constant until the mid-60s, although the reported levels of sulfur dioxide may be lower than the concentrations actually experienced by the subjects over the record period of 1952-62.

C. The Lave and Seskin report has been roundly criticized and should not be relied on.

R. The Lave and Seskin study is only one of a number of statistical studies that come to approximately the same conclusions although they started from different data and used different analysis techniques. It is valuable in that context.

C. Other reviewers of the paper (p. 66) by Verma et al. (1968) said that once the yearly cyclic behavior of absence rates are removed, there is no correlation between pollution levels and absence rates. Ho do you reconcile this interpretation with the one made in the draft EIS?

R. Because there is a causal relation between weather and air pollution levels it is difficult to separate these two effects. The weather and sulfur dioxide levels exhibit a parallel annual cyclical behavior. In an initial, simple analysis, Verma et al. adjusted the absence rates to reflect only changes from the monthly average. It is not too surprising that they found the adjusted variable did not correlate well to unadjusted pollution variables. Their two other more sophisticated analyses found a relationship between illness and the pollutant variables. A cell analysis for days with temperature less than 50° F. showed a statistically significant relation to days with CoH greater than 1.6 as mentioned in the draft EIS. A mathematical model showed increased reliability when pollution variables were included. Verma et al. conclude, "Higher SO_2 levels increased absence rates... there is a relationship between respiratory illness absences; air pollution, and climatic variables from one time period to the next."

C. The EIS (p. 67-68) quoted from two studies (Shy et al. 1973, and Hammer 1977) that were a part of the CHESS studies, which have been roundly excoriated by a Congressional committee.

R. The criticisms leveled against the CHESS studies were very specific. The two studies cited above were not subject to those criticisms. Secondly, even though Shy et al. (1973) was published in the CHESS report, it was not a part of that program. It was completed before the CHESS program started. The Hammer study followed the CHESS studies and did not make the same mistakes.

C. The Van Der Lende et al. (1975) study (p. 67) was primarily directed toward long-term effects rather than short-term (i.e. 24-hour). A subsequent study observed that the lung function measurements were not declining with age as expected.

R. The use of 24-hour values averaged over the testing period misled several readers. It was not possible to identify a specific change in lung function with the 24-hour average values reported for each day of the test, so the average of the values was reported to give some indication of the approximate daily average levels characteristic of the area. The annual average exposures might be substantially less. The subsequent study has not yet been published, but it would not be surprising if the normal loss of lung function with age has finally overwhelmed observed gains due to reduced air pollution.

C. The Sterling et al. (1967) study (p. 69) does not make clear what criteria were used to determine the illness of the patients nor is there sufficient data to know what the relevant air pollution levels were.

R. The criteria are stated in the original paper. The paper reports only average values of the pollutants, rather than the daily values that probably were the source of the reported association between illness and pollution. The draft EIS noted that the average sulfur dioxide level quoted is thus not convincingly relevant data.

C. The Lawther et al. (1970)(p. 69) study does not say that "suspended particulate, sulfur dioxide, and sulfuric acid mist were all significant and approximately equally important." It said "we have not been able to show which pollutant or combination of pollutants is responsible."

R. While it is not possible to say which pollutant is responsible for the effect, the authors' attempt to analyze the relative importance of the various pollutants is reported. All those mentioned had significant and approximately equal coefficients of determination. Both statements are correct.

C. It is not correct to say (p. 69) that Lawther et al. (1970) observed illness among elderly bronchitis patients when sulfur dioxide levels rose above 0.08 ppm.

R. The statement on pages 246-7 is a misinterpretation of the Lawther papers. A correct restatement of the paper appears on pp. 69 and 70 of the draft EIS. We regret the error.

C. The Carnow et al. (1969) (p.70) study failed to consider the effects of temperature or other pollutants or the effects of smoking and socio-economic status. It is thus not useful.

R. At the time this study was made, extensive measurement networks were not in place for other pollutants. However, measurements made a few years later indicated very low levels of ozone in Chicago. Particulate levels were not considered in the Carnow et al. study since they were not measured every day, which would have been necessary since the study measures daily reaction to pollutants. It is possible particulates could have contributed to the observed effects. The more than 500 individuals in the study came from all socio-economic and geographic areas in Chicago. Unless the smoking habits of the smokers in the sample fortuitously corresponded to changes in sulfur dioxide levels, smoking would have no effect since each person acted as his own control.

C. Contrary to the statement (p. 71) in the draft EIS, Cohen et al. (1972) did not suggest that asthma attack rates increased when sulfur dioxide levels increased above 0.07 ppm. This is simply the concentration that divides the "high" and "low" pollution days into groups of approximately equal number. Cohen did not ascribe the effects to any one pollutant.

R. It was an overstatement to imply that 0.07 ppm sulfur dioxide was observed to be a threshold of adverse effects. As stated in the draft EIS, the number of asthma attacks was observed to increase uniformly from the lowest level of pollution to the highest. Cohen et al. used the 0.07 ppm division to conduct a statistical analysis which showed, with 99 percent confidence, that the asthma attack rate on days of "high" pollution was greater than the asthma attack rate on days with "low" pollution. This level was partly chosen to evenly divide the total number of observations and partly Cohen et al. said, "because these were points at which relatively large increases in attack rate occurred." As the EIS says on p. 71, the increase in attack rates was associated with increases in several pollutants, and not just sulfur dioxide. It appears that all pollutants tended to increase at the same time, making separation of effects very difficult.

C. The asthmatic patients in the Cohen et al. study (p. 71) could have been responding to emotional factors, diet or just fudging their answers.

R. During one period the participants' self-evaluation of their condition was checked by a physician. The patient's subjective reports were found to be quite accurate.

C. The data in the Cohen et al. article have a correlation coefficient of only 0.4. There was no control group. It is overstating the results to say that the effect increased uniformly.

R. The actual data are reproduced in the article. While there is scatter around the best fit line (as would be expected in such a statistical experiment), the increase in effects is obviously uniform from low pollution days to high pollution days. There is no need for a control group since each person serves as his own control. This is a standard and well accepted technique in epidemiological studies.

C. Table III.A-II quotes all sorts of average concentrations for different periods, mixing them all up on the same table. Some of the entries are very misleading, especially where an average of daily values over a season is labeled as a 24-hour average.

R. The averages quoted in the table can be misleading. Except for the Kenline (1966) paper, the quoted 24-hour averages represent an average of daily values over the period of the study, which may or may not have any significance for a short-term health effect. In the Lawther et al. (1970) and Cohen et al. (1972) papers, the effects were observed by statistical correlation between increasing pollution levels and an increasing incidence of health effects. Therefore the effects are associated with a continuum of exposures from concentrations higher than the cited average to, possibly concentrations lower than the cited average. Neither of these studies identified a threshold of effects. The NRC review (1978) suggested that the relevant level for the Cohen et al. study is 0.08 ppm sulfur dioxide at 150 ug/m^3 TSP, as a 24-hour average. The NRC selected 0.10 ppm sulfur dioxide and 350 ug/m^3, 24-hour average as the critical levels for the Lawther et al. results. The Van der Lende study is even more difficult to interpret with respect to an appropriate "average" concentration, since the effects are thought to result from long-term exposures while the measurement data reported in the paper are short-term. The NRC review (1978) suggested that the relevant level for this study is 0.11 ppm sulfur dioxide at 225 ug/m^3 TSP, as a 24-hour average.

C. The EPA has issued a draft of its new criteria document for sulfur oxides. That document says sulfur dioxide is of relatively low toxicity and does not appear to be the cause of adverse effects on human health at the concentration normally found in ambient air.

R. The document referred to is not a draft of the criteria document but a draft of the project plan for the development of a criteria document. The comments are taken from a very general introduction to the effects of sulfur dioxide. The author of the EPA document told the Department that "relatively low toxicity" is intended to compare sulfur dioxide to other pollutants (effects from ozone are generally observed at concentrations four times lower than effects from sulfur dioxide) and that "concentrations normally found in ambient air" refers to levels below those proposed by Montana as its ambient standards.

C. The draft EIS cites numerous studies that observed health effects associated with both sulfur dioxide and particulate matter. Yet it ignores the implication that these two pollutants must be treated together and established separate standards for sulfur dioxide and particulate. From the data presented in the draft EIS, it appears that high sulfur dioxide concentrations seldom occur at the same time and place as high particulate concentrations. Thus the proposed standards will impose needlessly stringent requirements on Montana industries.

R. Although numerous studies have observed health effects when both sulfur dioxide and particulate were present, there is no substantial evidence that the effects would not have occurred in the absence of one or the other pollutant. It is a most difficult position to be unable to say which pollutant is primarily responsible for the effects, or if it is a synergism that requires the presence of both pollutants. Some researchers have suggested that the synergistic effect may occur only at the higher concentrations typical of emergency episodes and that is why increased deaths occur at these levels, which are only two or three times the more ordinary levels where effects are not nearly as dramatic. In the absence of information clearly identifying one or the other pollutant, prudence requires that the standards be set separately. If synergism were demonstrated at either high or low concentrations a single standard could be set with the benefits to Montana described by the commentator. However, that is not possible with the information currently available.

C. During the inversion occurring in Billings on December 18, 1978, several patients reporting into a local clinic felt strongly that their ability to breathe was impaired. The Billings air pollution data indicated no pollutants exceeded the proposed standards that day. That suggests that other pollutants were responsible, or that meteorological conditions alone were responsible, or that the patients convinced themselves they should be worse because of the poor visibility and the attendant publicity.

R. This illustrates the difficulty inherent in epidemiological studies. Before anything definite can be said it is necessary to do massive studies involving lots of people. The analysis must necessarily be done by statistical procedures. The results are always less than wholly satisfying and leave unanswered questions. For example, it is also possible that these patients were exposed to very high levels of pollutants that may have occurred at a specific place some distance from the monitoring station.

C. Doctors in Billings have observed a lot of chronic bronchitis that is not explained by cigarette smoking or asthma. Some people are known to be sensitive to cigarette smoke at extremely low concentrations, so it should be expected that some people also will be sensitive to air pollution at low levels. There is no solid evidence that there is a threshold of effects.

R. The recommended standards were formulated with the sensitive individual in mind, and with the assumption that there probably was no threshold for some pollutants.

C. Bouhuys, et al. (1978) showed that at 0.19 ppm of sulfur dioxide and 250 ug/m^3 TSP there is no effect on the lung function of non-smoking men working outdoors.

R. This is a misinterpretation of the Bouhuys et al. study, although the mechanics of the study were acceptable. The study examined two communities, one with annual sulfur dioxide concentration of 0.004 ppm and particulate levels of 40 ug/m^3 TSP and the other with 0.005 ppm sulfur dioxide and 63 ug/m^3 TSP. It should not be surprising that they found no difference in lung function between the residents of these two cities. They did observe significantly higher cough and phlegm in the "high" pollution city among non-smokers, and a significant increase in labored breathing among both smokers and non-smokers. However, the authors concluded they could not distinguish between air pollution and other urban conditions that might have contributed to this difference.

C. The Bouhuys et al. study (in press) shows children living in a part of Czechoslovakia with sulfur oxide annual average of 0.06 ppm have the same lung function as children in rural South Carolina and Connecticut who live in an area of less than 0.01 ppm. This indicates long-term overall respiratory function is largely unaffected by sulfur dioxide annual averages.

R. This paper has not yet appeared in the journal referred to and is not available for a review by the Air Quality Bureau. Because there are often substantial differences in lung function between ethnic and racial groups, such studies are often done in nearby geographic areas and it is not clear how the wide geographical separations affect their study.

C. The draft EIS ignores many recent studies and reports on sulfur dioxide that would have been useful, such as the December 1978 special issue of the Annals of the NY Academy of Medicine and the National Research Council report, also published in December, 1978.

R. The two reports cited both arrived in the library after the publication of the draft EIS. However, both have been carefully reviewed by the Department. The studies reviewed by the National Research Council (NRC) report were available to the Department. The report does not present any new data, although it does contain the conclusions of the NRC committee, which are quoted in the following comment responses. The papers in the New York Academy of Medicine special issue are all reviews of data that have appeared elsewhere, except for the report by Schimmel (1978), which is a further extension of the study by Schimmel and Murawski (1976) that was discussed in the draft EIS. The issue contains some interesting critiques of the Schimmel study by Goldstein and Goldstein (1978) and Tukey (1978).

C. The overwhelming scientific consensus is that sulfur dioxide is much less of a hazard to health than the draft EIS would have us believe. A recent report on sulfur oxides by the National Research Council concluded that the

federal standards are quite adequate to protect the public health. And at the recent meeting of the New York Academy of Medicine, speaker after speaker argued that the sulfur oxides problem was overstated by previous research.

R. The National Research Council report referred to says: "To the extent that the effect of sulfur dioxide can be separated from the effects of particles in the data reviewed, the present 24-hour primary standard for sulfur dioxide is 0.14 ppm is reasonable. Population exposures at this concentration are associated with a slight increase in asthmatic attacks and reversible changes in pulmonary function." Note that they conclude that health responses may be observed at the level of the federal standards.

Several speakers at the NYAM meeting indicated their research suggests sulfur oxides to be less significant than previous research had indicated. However this does not mean these scientists believe sulfur dioxide to be harmless at the concentrations recommended by the proposed Montana standards. At the NYAM meeting, Dr. P. J. Lawther said, "I think the villain probably is SO_2. Our finding to date is that with deep, aided breathing we can make a part per million produce increases in airway resistance. I think by extrapolation if one looks at the non-homogenous lungs which characterize our type of severe emphysema, one would not under any circumstances submit one of those patients to 0.5 part per million of SO_2 because I think one could harm them." While Dr. Lawther said, as the comment points out, that much of the U. S. emphasis on sulfur oxides control is misplaced (he would prefer to see the effort expended on controlling cigarette smoking) he would not want to subject a sensitive person to an exposure of sulfur dioxide above the proposed standard.

C. The draft EIS clearly stated the need for a margin of safety in conjunction with any standard. Yet you acknowledge that the 24-hour average sulfur dioxide standard may not include any margin of safety. In fact, several of the studies which you cite reveal adverse health effects at levels of 0.07 ppm and 0.08 ppm sulfur dioxide, 24-hour average. Not only is there no margin of safety, but you have failed to protect the public health.

R. The draft EIS created a misunderstanding of the basis for the AQB's recommendation for a 24-hour standard. As explained in this final EIS, the primary motivation for the standard is the observation by Lawther (1963) that increased deaths can be expected above 0.25 ppm sulfur dioxide in the presence of substantial levels of particulate matter and Lawther et al. (1970) said adverse effects were seen in a sensitive group above 0.19 ppm sulfur dioxide in the presence of particulates slightly in excess of the present 24-hour federal standard. However, there are indications in the Lawther et al. study as well as the other studies cited in the draft EIS that effects might be seen at lower concentrations. These latter studies do not define any clear threshold of effects. The concentration associated with these studies in the draft EIS and repeated in the comment are misleading, as has been pointed out by other comments. The AQB staff was aware of the correct interpretation of these studies but stated it poorly in the EIS. These latter studies do not form any hard basis for the establishment of a standard at the levels quoted. Rather they argue for a safety factor of at least two. If this is applied to the 0.19 level suggested by Lawther

et al., then a standard of 0.10 ppm is required. Because all these studies suggest there may be no lower threshold of effects, it is possible that no standard at any level would provide a margin of safety. The Department believes that the standard suggested is sufficiently below the levels associated with substantial health effects that the public health will be protected although a small risk remains.

C. The consensus among experts who have reviewed the literature is that the lowest annual average sulfur dioxide concentration at which effects have been definitely seen is around 0.04 ppm sulfur dioxide in conjunction with particulate matter above about 200 ug/m^3 annual average. This level of particulate matter is more than twice the federal standard for particulate matter and is at least twice the highest level in Montana reported in the draft EIS. Is not the absence of high particulate levels enough of a margin of safety for the sulfur dioxide standard? Why do we need an additional factor of two?

R. The Department's review of the literature also indicated that 0.04 ppm is the annual average concentration of sulfur dioxide that should be of primary concern in setting the standard. Although most health effects studies of sulfur dioxide have occurred in areas with moderately high particulate, there is only limited evidence of a synergistic effect at these lower concentrations. Therefore consideration of the proper margin of safety to apply must be independent of the expected particulate levels. If the presence of particulate proves to be an integral contributor to the effect then the standard should be written in terms of both sulfur dioxide and particulate, rather than simply relaxing the margin of safety.

C. The sulfur dioxide health effects data base is not sufficiently precise to allow distinction of long-term health benefits between 0.02 ppm and 0.03 ppm.

R. Both the EPA and the Department have established 0.04 ppm as the level of apparent health response. The standard proposed in the EIS is more stringent than the federal standard because the Department has determined that a greater margin of safety is warranted.

C. The proposed sulfur dioxide standard would not protect human health.

R. There is probably no threshold of effects for sulfur dioxide. However, the effects at low concentration may not be adverse to health. Epidemiological evidence indicates that overt disease and aggravation of pre-existing conditions occur primarily at concentrations in excess of the proposed standards.

C. It is not clear that sulfur dioxide is responsible for the adverse health effects reported in several studies. Several analysts have suggested that sulfur dioxide may be only an indicator of pollution in general, while the true cause of the health effects may be particulates or some unknown and as yet undiscovered chemical in the air (e.g. some organic hydrocarbon).

In some of the studies cited in the EIS (e.g. Wicken and Buck 1964, Douglas and Waller 1966, and Lunn et al. 1967) the particulate levels may be much more important than the sulfur dioxide concentrations in causing the observed health effects, yet the draft EIS relies on these studies to establish an annual standard for sulfur dioxide.

R. Because elevated particulate concentrations are frequently observed where sulfur dioxide concentrations are high it has been very difficult to conduct epidemiological experiments that distinguish between the effects of the two. In addition, sulfur dioxide converts to a particle.

It has been frequently suggested by British researchers that the substantial reduction in health effects they have observed was due to the control program on particulates. Although there was no specific control program onsulfur oxides, there has been a substantial reduction in measured sulfur dioxide concentrations also, in part due to improving meteorological conditions as the dark blanket of particulates was removed. In short, the British experience does not completely clarify the roles of these pollutants in affecting health, despite the evidence for effects from sulfur dioxide exposures at the reported concentrations. These British studies nevertheless remain the very few available on the long term effects of pollutants on health, and are cited by many reviewers as evidence that sulfur dioxide causes health effects at the exposures reported.

Other analysts (e.g., Schimmel) have suggested that sulfur dioxide is merely an indicator rather than directly associated with increased death rates because of the behavior of the sulfur dioxide coefficients in their statistical studies. This conclusion is based on an assumption about the way these coefficients should behave and therefore there is no reason to accept their conclusions.

C. It is not clear what margin of safety was used in determining the annual particulate standard. The standard of 75 ug/m^3 is no simple fraction of the lowest observed effect level of 130 ug/m^3.

R. The measured value of 130 ug/m^3 was based on a geometric average suspended particulate measurement. When expressed as an arithmetic average, the value is approximately 140-145 ug/m^3. The 75 ug/m^3 standard is expressed as an arithmetic average. Thus it is approximately half the corresponding level of measured effects.

C. It does not appear that any safety factor was considered in establishing the daily suspended particulate standard. Some studies are reported that seem to have lower levels.

R. Because the British and Dutch studies used a different measurement technique they cannot be directly compared to the measurement technique proposed. In addition it is not clear that all the particulate matter measured is of similar composition. The Cohen study used 150 ug/m^3 as a dividing line between high and low pollution days for a statistical study. This cannot be considered a level at which effects were actually detected. Adverse effects

anticipated at particulate levels above 300 ug/m^3. A standard of 200 ug/m^3 would appear to protect the public health.

C. The draft EIS made it very clear that the primary health concern should be directed toward particles with less than 15 micrometers diameter. Why was a standard proposed for total suspended particulate, rather than for particulate less than 15 micrometers?

R. Since a standard is being proposed for settled particulate, which primarily relates to large particles, it would be entirely reasonable for the suspended particulate standard to be defined with respect to fine particles. Some studies have measured fine particle concentrations in association with observations of health effects. However, these measurements have used a wide variety of definitions of "fine particle." There is simply not enough data available at this time to even allow a guess as to what an appropriate standard should be. When sufficient data are available to support a specific proposal, the Department will recommend adoption of a new standard, specific to particles less than 15 micrometers.

C. It is possible that the total suspended particulate measurement might contain all small particles. That much small particulate would be devastating.

R. It is possible that if the suspended particulate were made up entirely of small particles adverse health effects might be expected without the standard being exceeded. However, such a distribution of particle sizes is not expected in Montana. Wind-blown and re-entrained dust is a more common problem. Such dust contains only about 20 percent fine particles.

C. Dust concentrations found in rural areas consist primarily of large particles, with little or no sulfur oxide present. Under these circumstances a less stringent standard could be used.

R. It is correct that a given concentration of large dust particles is of less concern than an equal concentration of fine particulate. This is one of the reasons that separate standards are desirable for large and small particulates. It should be remembered that sulfur oxides may be carried into rural areas from pollution sources such as coal-fired power plants. Further, the experiments forming the data base for the particulate standard were performed with low sulfur oxide concentrations.

C. Why did the Bureau change the total suspended particulate standard from geometric mean to arithmetic mean? This may be especially critical when considering that most of the studies cited by the EIS gave annual TSP levels in geometric means. This also results in a significant tightening of the particulate standard.

R. The arithmetic mean was used to maintain consistency with all the other standards and for convenience in computation. The arithmetic mean is much easier to work with than a geometric mean. The geometric mean is important in analysing log-normally distributed data, but it is useful only if one also knows the geometric standard deviation, which is seldom known. Arithmetic means tend to reflect more strongly the few days of very high values, which are important in determining the likelihood of health and environmental effects. Most other pollutants also obey a log-normal distribution of data, but they are all controlled by arithmetic average standards. There is no particular advantage to the source or to the Department in using a geometric mean for the TSP standard. It should have been made more clear that the data reported for the health and environmental effects often, although not always, utilized a geometric mean. The differences are small. Here are some comparisons of Montana data:

Site	Arithmetic Mean	Geometric Mean	G/A
Greeley School Butte, 1976	107	92.3	.875
Courthouse Missoula, 1977	94.6	82.8	.875
Johnson-Bell Missoula, 1977	53.0	45.8	.864
Richer Butte, 1977	22.0	19.2	.873
Traphagen Hall Bozeman, 1978	34.0	27.7	.815
Grand Ave. School Billings, 1977	53	43.6	.827
City Hall Billings, 1977	63	57.9	.919
KGHL Billings, 1977	38	32.5	.855
Lockwood School Billings, 1977	55	47.7	.867
Hardin Hardin, 1977	25	14	.696
Thomas Ranch Decker, MT	40	40.3	.822

G/A = ratio of geometric mean to arithmetic mean

The average G/A = .844 with a standard deviation of .057. The correlation coefficient between geometric means and arithmetic means = .997. This review suggests that there is a strong relationship (at least for Montana) between the geometric mean and the arithmetic mean. On the average, the geometric mean is about 15 percent lower than the arithmetic mean.

Using this factor, the proposed annual standard for TSP of 75 ug/m^3 is the same as a standard of 63 ug/m^3 if a geometric mean had been used.

C. The annual average concentrations of particulates cited in the Lawther study on page 70 is incorrect. It should be 68 ug/m^3 BS instead of 204 ug/m^3 BS. However, this average exposure does not tell us anything about the concentration of the pollutants necessary to cause the effect.

R. In community epidemiological studies, it is very difficult to ever identify a specific level which causes an effect. More often, the study identifies an "association" between elevated pollution and increased health effects. If a statistically significant relationship is observed (as it was in the Lawther study) then an increase in pollution was often parallelled by an increase in observed effects. A common estimate of the specific concentration which would be associated with the effects is the D + 1 standard deviation. D + 2 standard deviations will include almost all of the data points. Thus the effects can be associated with pollution concentrations between 0.11 and 0.15 ppm of sulfur dioxide and 116 to 164 ug/m^3 BS of particulate matter.

C. The draft EIS fails to cite several studies which observed adverse health effects from sulfur dioxide when particulate levels were low. The EPA conducted studies in the Salt Lake City area and in towns in Montana. These studies showed increased rates of respiratory disease in the communities with higher sulfur dioxide concentrations. Kerredijn et al. (1975) found a higher incidence of cough and chronic respiratory disease in children living in an area of higher sulfur dioxide exposures.

R. As discussed on page F-14 of the draft EIS, the Department set aside the EPA CHESS studies including the Salt Lake Basin and Rocky Mountain Communities Studies because of the controversy surrounding the studies. This may have been an unnecessarily harsh step since the critics (Committee on Science Technology, 1976) had provided sufficient analysis to permit a reevaluation of these studies.

In the two CHESS studies mentioned (Finklea, et al., 1974) the researchers distributed medical history questionnaires to school children. Approximately 9,000 children were included in the Utah study and 6,000 in the study of children in Helena, East Helena, Bozeman, and Anaconda, Montana and Kellogg, Idaho. Parents were asked to report incidents of chest colds and similar illnesses over the past three years. A sample of the questionnaires was validated against family physician medical records. Children with asthma were excluded from the study. In the Utah studies a statistically

significant higher incidence of lower respiratory disease was observed in the areas with high sulfur dioxide pollution. In the Montana studies a higher incidence of croup was observed in the smelter communities.

A primary criticism of these studies was the unreliability of the sulfur dioxide emissions. Chemicals were spilled in shipment to the laboratories and temperature sensitive chemicals were not held at constant temperature. This led the critics to conclude that the annual average measurements might be low by at least 15 to 20 percent. Taking this into consideration, the sulfur dioxide concentrations may be estimated to have been above 0.03 ppm annual average in the high pollution Utah communities, and 0.01 ppm annual average in the low pollution Utah communities. The total suspended particulate measurements were made by the same high volume technique currently in use. The particulate concentrations were approximately 70 ug/m^3 annual average in each Utah community. No pollution measurements were made in the Montana communities. The Kerredijn et al. study involves school children in West Holland. Medical histories were collected from about 2,500 children. Lung function tests also were conducted. A higher incidence of cough and chronic respiratory disease was observed in these high po-lution areas. The difference in lung function tests is not statistically significant. Concentrations of sulfur dioxide were 0.01 ppm annual average in the low pollution areas and 0.06 ppm annual average in the high pollution areas. Particulates averaged less than 40 ug/m^3 in both areas.

COMMENTS ON THE NONHEALTH EFFECTS OF SULFUR DIOXIDE AND PARTICULATE

C. The authors of the draft EIS do not mention that the proposed sulfur dioxide standards are the same as those established by the EPA in the early part of the decade. The EPA did not implement the standards because of ambiguities in the experiments upon which the standards were based.

R. The EPA standards discussed above were established to protect vegetation. The proposed Montana standards are based, not on protection of vegetation, but of human health.

C. The definition of a nuisance from dustfall is (p. 104) based on a household survey yielding highly subjective opinions by nonscientific people. The average person does not know what quantity of pollution would be required to cause detrimental effects.

R. The intent of the study was to compare the attitudes of common people to observed pollution levels. This study showed a uniformly increasing annoyance among the population as pollution increased. You don't have to have a Ph.D. to know the window sill is dirty. The settled particulate standard is designed to protect common people from the nuisance of dustfall from air pollution. They are the best people to ask to find out if they are annoyed.

C. The draft EIS fails to include a discussion of particulate effects on crops, livestock, and ecosystems in its justification of a standard for this pollutant.

R. Particulate levels necessary to cause harm to crops, livestock, and ecosystems are much higher than those believed to injure humans. A standard that will protect human health will protect other types of life as well.

C. The work of Scheffer and Hedgecock (1955) should not be used as a basis for a 24-hour sulfur dioxide standard.* Their study found visible injury at levels far higher than the proposed standard.

R. The study conducted by Scheffer and Hedgecock found significant visible injury at 0.53 to 0.60 ppm sulfur dioxide after a seven-hour exposure. Because the effects noted at seven hours were significant and affected many Montana forest species, The Department attempted to extend this information to predict an equivalent 24-hour concentration. The dose-response equation of O'Gara (1922) was used to determine an appropriate 24-hour concentration.

O'Gara found that an equation could be constructed to predict a level of sulfur dioxide that would cause plant damage over a given time interval once a known concentration and exposure time was determined. Thus, based on the equation of O'Gara, a 0.53 ppm/7-hour exposure is equivalent to a 0.15/24 hour exposure. There is a certain amount of uncertainty in this method due to the assumption that plant uptake of sulfur dioxide is equivalent during both the daylight and dark portions of the averaging period.

C. The proposed standards for sulfur dioxide are not adequate to protect vegetation and do not consider the synergistic effects of combined ozone and nitrogen oxide concentrations.

R. The experiments presented in the draft EIS on the effects of sulfur dioxide on plants indicate that most plant species found in Montana would be protected. There is some question as to whether the proposed standards would protect vegetation when sulfur dioxide was accompanied by ozone or nitrogen oxides at concentrations in compliance or violation of federal standards for these pollutants. The experiments that raise this question are ambiguous in defining a safe level for sulfur dioxide. Most, if not all experiments that have documented synergism were conducted on non-Montana plants under conditions different than those experienced in this state and therefore add to the uncertainty in quantifying vegetation damage from multiple pollutants.

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*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

C. Plants close leaf stomata and do not take up air pollutants at night. This indicates that vegetation should not be considered when setting a 24-hour sulfur dioxide standard.*

R. Vegetation can be affected by air pollutants at night in a variety of ways. Guderian (1977) says:

> *Because the stomata of most plants are closed in darkness, it was generally thought that pollutant action during the night would have little or no effect. Van Hout (1961) and Zahn (1963b), however, were able to disprove this assumption in experiments with sulfur dioxide. Although action of pollutants during the night has less severe effects than during the daylight, both effects must be considered together, as exposure during the night can intensify the effects of daylight exposures.*

C. The work of Linzon (1971) which showed significant reductions in timber yields to eastern white pine at an annual sulfur dioxide level of 0.03 ppm used a highly sensitive species and is therefore irrelevant to a Montana standard.*

R. As stated on p. 89 of the draft EIS, Linzon (1972) ranks Douglas fir, ponderosa pine, and western larch as sensitive as eastern white pine to damage from sulfur dioxide.

C. Although the work of LeBlank et al. (1972) showed elimination of lichens at average sulfur dioxide levels between 0.01 and 0.02 ppm, the results are invalid because of excessively high short-term sulfur dioxide levels during the averaging period. Furthermore, lichens are not essential for the survival of Montana ecosystems.

R. It is true that the LeBlank et al. study was conducted in part in an area that had several high short-term concentrations of sulfur dioxide, but the study was not confined to these areas. The portions of the study area cited in the draft EIS had few or no high short-term sulfur dioxide concentrations. Extensive losses in lichen populations were noted where the actual short-term sampling averages were less than 0.1 ppm sulfur dioxide and annual averages were approximately 0.01 to 0.02 ppm.

Lichens and bryophytes are vital to the continuation of functioning ecosystems in Montana, or anywhere else. They contribute to the formation of soil by oxidizing rocky material, and are used as food by much of Montana's wildlife, particulately in winter. They also provide shelter for insects and small mammals.

*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

C. The EPA analyzed the Linzon (1971) study and concluded that the injury reported could not be documented as resulting from the average sulfur dioxide concentration over a full year or even the six-month growing season, as distinguished from short-term peak concentrations. EPA therefore withdrew the national secondary standard of 0.02 ppm. The Montana proposed standard should be dropped from consideration for similar reasons.*

R. The proposed standard of 0.02 ppm is based on human health considerations. The Linzon study is valid for determining the effects of long-term sulfur dioxide concentrations on plants.

It is true that high concentration peaks occurred during the years Linzon's study discusses. However, Guderian (1977) does not feel that the resulting injury is different than that from long-term low concentration exposures at roughly the same yearly average. Guderian analyzed work conducted near Trail, B.C. which had several high short-term exposures followed by large numbers of pollution free time periods. Damage to ponderosa pine resulted at yearly averages of 0.03 ppm sulfur dioxide. He then compared these results with European studies where long-term low concentrations cause injury to forest trees at 0.02 ppm sulfur dioxide. Guderian summarized his findings:

> *The field studies described here were carried out under considerably different pollutant conditions: one was characterized by high peak concentrations and long pollutant-free times, the other by long-term action of low concentrations. Based on the average concentrations, however, the injury limits are in the same range. The extreme phytotoxicity of the pollutant type with high peak concentrations results from the progressive increase of acute injury, while an increase in action of low concentrations rests on cumulative effects of the pollutant and the absence of pollutant-free times which allow the plant to recover. This is especially true for long-term effects on fruit and forest cultures, as slight effects can add up over a period of years or even decades and cause a reduction of the useful value of the plant.*

The proposed sulfur dioxide standard should protect against the cumulative nature of sulfur dioxide effects over an annual sampling period. The work of Linzon (1971) is helpful in predicting effects for forest crops in Montana.

C. The Constantinidou et al. (1976) study reported in the draft EIS should not be considered when setting a one-hour sulfur dioxide standard.* The suggestion that the study indicates a reduction in the regenerative ability of forests is a serious misrepresentation. Further, the conclusions derived from the study are in error.

*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

R. The Constantinidou et al. (1976) paper has been reviewed in light of the above comment. Re-analysis indicates that both dry weight and chlorophyll content of red pine seedlings were significantly reduced from controls by 0.5 ppm sulfur dioxide after 15, 30, 60 and 120 minute exposures. The 15 and 30 minute exposures showed damage even though the time periods are shorter than in the proposed standard. The sensitivity of red pine to sulfur dioxide is ranked equal to that of western forest trees (Linzon 1972).

The suggestion in the draft EIS that this study indicates possible inhibition of forest regeneration comes from the Constantinidou et al. study. Constantinidou et al. said:

> *The data suggest that continuous fumigation with SO_2 at much lower dosages than used in these experiments may have important inhibiting effects on seedling development and on regeneration of plant communities.*

C. The White et al. (1974) study quoted in the draft EIS did not say that sulfur dioxide interfered with growth. Rather it said that certain dosages of sulfur dioxide produced certain reductions in photosynthesis.

R. This is correct. The statement made on p. 246 is in error. It should read "White et al. (1974) found that exposure of alfalfa to 0.35 ppm sulfur dioxide for one-hour caused a reduction in apparent photosynthesis."

C. The discussion of weather modification relies on too many hyoptheses and too few facts.

R. Weather modifications by airborne particles is still a poorly understood phenomenon. Although it is known to happen, the mechanisms remain a subject of research and investigation. This section only intended to state the scope of the problem, not to define it precisely.

C. No mention was made in the draft EIS of the work of Dr. Donald H. Hasting relating weak-calf syndrome to selenium deficiency caused by sulfur dioxide pollution from coal-fired power plants.

R. Dr. Hastings' hypothesis is interesting, but there is no experimental work to test the relationship between weak-calf syndrome and sulfur dioxide pollution.

C. The effects of sulfur dioxide on mychorriza (a root fungi, important to optimum growth in many plants) was not discussed in the Draft EIS.

R. Work conducted on mychorriza and described in the Fourth Interim Report on the Bioenvironmental Impact of a coal-fired power plant (1978) was published too late to be included in the draft EIS. The study cited in the interim report gives preliminary evidence indicating that the number of mychorriza in western wheatgrass is reduced by sulfur dioxide. The concentrations necessary to elicit an adverse response were not presented.

C. The MAAQS working paper on sulfur dioxide and particulates contained a comprehensive summary of the crucial ecosystem functions of lichens and detailed their importance in agricultural, timber and reclamation efforts. This important summary was deleted from the draft EIS.

R. The discussion of lower plants on page 91 of the draft EIS is nearly identical to the discussion presented in the working paper on sulfur dioxide and particulates.

C. The lawsuit Steyer vs. Monongahela Power Company (Civil Action No.s 12-452-M, 12-453-M, 72-560-M, 73-731-M, E.Md; June 2, 1977) determined that the defendant power companies were not at fault in causing damage to vegetation near Mt. Storm, Maryland. Therefore, the EPA study (1971) which found damage to vegetation there is suspect.

R. Legal opinions are not a basis for evaluating scientific research.

C. Use of Houston (1974) and Berry (1971) to substantiate sulfur dioxide damage to vegetation is not warranted because these experiments used combinations of sulfur dioxide and ozone.

R. The portion of the Houston (1974) and Berry (1971) experiments cited in the draft EIS dealt solely with effects caused by sulfur dioxide. Their experiments with ozone and sulfur dioxide would have been appropriate and would have been used if ozone levels were similar to those found in Montana. However, these researchers used ozone concentrations somewhat higher than have been recorded in Montana.

C. The article by Scheffer and Hedgecock (1955) contained a statement not set out in the Draft EIS discussion that "the minimum concentration of SO_2 required to injure coniferous trees appears to be not less than 0.25 ppm." The draft EIS authors refer to a study by Katz and McCallum (1939) who "found that during the growing season pine and Douglas fir could tolerate this amount (0.25 ppm) continuously for 450 hours." Neither of these studies can support a 24-hour sulfur dioxide standard of 0.10 ppm.*

*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

R. The statement attributed to Scheffer and Hedgecock (1955) and cited above pertained to 0.25 ppm sulfur dioxide at exposure durations of seven hours or less. A 24-hour concentration somewhat lower than 0.25 ppm probably would be as damaging to coniferous trees as 0.2 ppm for the seven-hour or shorter periods. The statement by Katz and McCallum (1939) is correct but needs some qualification. Their researchers made the above statement only for mature ponderosa pine and Douglas fir growing at sites where their controlled fumigations took place. In another portion of their study the researchers used transplanted conifers to determine injury levels from sulfur dioxide. During these experiments western larch was tested and found to be the most sensitive conifer to sulfur dioxide, showing injury at 0.30 ppm after eight hours of exposure. Furthermore, ponderosa pine and Douglas fir seedlings, not previously tested, were injured at 0.29 ppm sulfur dioxide at a 44-hour exposure. Thus, these two tests show that the Katz and McCallum statement cited above dealt only with mature ponderosa pine and Douglas fir and that different tree species or similar trees at more vulnerable periods in their growth cycle could be injured by less than 0.30 ppm sulfur dioxide at much less than 450 hours of exposure.

C. The draft EIS is seriously deficient because it fails to consider factors other than sulfur dioxide which affect growth and survival of vegetation and the way which sulfur dioxide may affect plants (genetic development, temperature, humidity, light, and so on).

R. Although considerations cited above may be important for an understanding of methods of action by which sulfur dioxide injures plants, they have less significance in setting a sulfur dioxide standard adequate to protect vegetation. The standard setting process, by necessity, must consider the portion of the plant's lifetime, temperature, soil, conditions and other influences that define the periods of greatest sensitivity in plants. A consideration of what levels are low enough to be harmless during the most sensitive period insures protection at other less sensitive times.

C. The draft EIS should not ignore the fact that only an extremely small segment of Montana vegetation is exposed to any significant levels of sulfur dioxide.

R. The draft and final EIS consider the amount of Montana vegetation impacted by sulfur dioxide. An economic analysis (Otis *et al*. 1979) was used to weigh the significance.

C. The uncertainty and potentially great risk involved with low levels of sulfur dioxide over many years should be given greater emphasis.

R. Long-term adverse effects to ecosystems from sulfur dioxide are most commonly associated with conversion to sulfuric acid. These effects were discussed in the draft EIS. Long-term adverse effects from sulfuric acid are not well understood at this time.

C. The draft EIS says that Bennett and Hill (1974) found a reduction in barley and oat photosynthesis at 0.2 ppm sulfur dioxide after one-hour of exposure. This implies a reduction in yield when in truth the authors state that photosynthesis returns to normal with the cessation of exposure.

R. Although the authors point out that photosynthesis returned to normal following exposure, it is important to note that there are several experiments indicating 0.2 ppm exposure extended for longer durations probably would decrease yield in these plants.

C. Validity and conclusions drawn from EPA (1978) studies near Colstrip on visible injury to western wheatgrass are not warranted.

R. The study design used in the Colstrip studies was scientifically valid. Growing season average sulfur dioxide concentrations of 0.05 ppm caused a statistical increase in visible injury over controls. An increase in visible injury was noted at growing season averages of 0.02 ppm sulfur dioxide, although not to a significant degree.

C. The statement (p. 83) that reductions in internal plant processes can cause growth and yield losses without visible injury attributed to Thomas (1961) is a misrepresentation of the author's conclusions.

R. Thomas (1961) made his statement with the caveat that "this has not yet been definitely established." More recently other plant scientists (Bell and Clough 1973; EPA 1978; Bleasdale 1952; Reinart _et al_. 1969; Tingey _et al_. 1971) have conclusively demonstrated growth and yield can be reduced in the absence of visible symptoms of injury. These studies reached their conclusions using better laboratory and ambient air exposure than were avilable during Thomas' work.

C. The draft EIS said the synergistic effects of sulfur dioxide with other pollutants have been documented. It is important to note that the experiments described have not been confirmed outside of the laboratory.

R. It is correct that experiments which depict synergistic effects from pollutant combinations have not been confirmed outside the laboratory. The complexity of effects from pollutant combinations in the ambient air begs for sophisticated experimental techniques that currently are in their infancy. The draft EIS makes the point that under situations such as this, one needs to depend on laboratory experiments to define a level of concern. However, it also points out that laboratory experiments tend to underestimate the consequences that may take place in the ambient situation. Much work that is necessary before the true effect from pollutant combinations in the ambient air can be realistically defined.

C. Exposure situations in areas outside Montana where sulfur dioxide damage to vegetation has occurred are unlike those found in Montana. Therefore any such comparisons used are invalid for consideration in setting standards for Montana.

R. Researchers have shown that average concentration levels and not exposure situations are the determining factor in causing vegetation damage. Only exposure levels were compared in the draft EIS.

C. The Guderian (1977) study which showed a 15 percent yield loss in wheat at annual sulfur dioxide levels of 0.015 ppm should not be considered in setting a sulfur dioxide annual average standard.* The selected data used by the authors do not reflect the true sulfur dioxide exposure.

R. The Guderian (1977) studies were calculated using ten minute periods where sulfur dioxide was at least 0.10 ppm. In the absolute sense this ignores the concentrations below 0.10 ppm that may contribute to a higher total exposure over the year, and thus a higher annual average. The authors felt that levels lower than 0.10 ppm did not have a negative effect on the plant tested and could be ignored.

It is not possible to derive an accurate annual average from the Guderian work. The actual average probably was closer to 0.02-0.025 ppm.

C. At an average sulfur dioxide level of 0.015 ppm, a 15 percent yield loss in wheat was noted in the draft EIS. Given the marginal profitability of eastern Motana range and grasslands, a level such as this would mean a net loss to farmers in these areas.

R. The assumptions of this question are based on a misinterpretation of the Guderian (1977) study presented in the DEIS. See above comment.

C. The EPA (1971) study cited in page 90 of the draft EIS should not be used in consideration of the proposed sulfur dioxide annual standards.* This study was conducted in an area where large amounts of other toxic air pollutants coexisted with sulfur dioxide. Other air pollutants than sulfur dioxide were responsible for the observed injury.

R. The EPA (1971) study suggests that increased toxicity of sulfur dioxide in combination with other air pollutants can take place under field conditions. Contrary to the conclusion noted in the comment above, the EPA diagnosed the vegetation injury as resulting from sulfur dioxide and not from other pollutants measured in the study.

*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

C. The DEIS reported that the study by Horseman and Welborn (1975) indicated a threshold for sulfur dioxide at 0.15 ppm for six days. In fact that study reported a threshold at 0.20 ppm for six hours.

R. Correct.

C. The Applegate and Durrant (1969) study cited in the draft EIS indicated injury to peanuts at sulfur dioxide concentrations of 0.02 to 0.03 ppm for 2-48 hours. The authors actually report that injury occurred on high moisture plants four-eight hours after fumigation at sulfur dioxide concentrations of or fluctuating between 0.05 to 0.12 ppm.

R. The object of the Applegate and Durrant (1969) study was to confirm a hypothesis that peanut crops were injured during the passage of frontal systems in Texas by combinations of ozone and sulfur dioxide. A laboratory experiment was conducted to try to duplicate pollution levels of these two gases associated with the observed damage to peanut crops. Results of the experiment indicated that high moisture plants were damaged by ozone at 0.02 to 0.03 ppm after 24 to 48 hours, by sulfur dioxide at 0.05 to 0.12 ppm after five to eight hours, and at ozone concentrations of 0.008 to 0.01 ppm together with sulfur dioxide levels of 0.02 to 0.03 ppm after four to five hours. In all experiments low and medium moisture plants were damaged 8 to 10 and 10 to 14 hours after development of symptoms in high moisture plants.

Plant damage from ozone and sulfur dioxide in combination at lower levels than when administered singly indicates they act synergistically on peanuts. Furthermore, the symptoms induced by the synergistic action of ozone and sulfur dioxide on peanuts in the laboratory were identical to those observed in field grown plants. The authors said that although the possibility of synergistic effects has been demonstrated in controlled conditions, it does not prove the same phenomenon exists in the field. Synergistic effects of ozone and sulfur dioxide on peanuts under laboratory conditions was confirmed in this experiment and it was suggested that similar action occurs under field situations at similar pollution levels.

C. Protection of bryophytes and lichens should be accomplished by the prevention of significant deterioration (PSD) approach rather than by ambient air standards which must be met throughout urban, suburban, and industrialized areas.

R. Due to the uncertainty of pollutant baseline determinations uder PSD and to the extreme sensitivity of byrophytes and lichens to sulfur dioxide, the PSD regulations cannot insure protection under all conditions.

C. A number of experiments cited in Table III A-III measured effects on detached plant leaves, plant chemistry , isolated internal plant organs, or found minor changes in stomatal resistance that should not be extrapolated to occur under field situations.

R. The experiments referenced above were included in Table III A.III to explain the nature of sulfur dioxide effects on plant functioning and growth. These experiments were designed to gather vital information that could not be obtained in other ways, and are valuable because they show sulfur dioxide can affect many plant systems at very low concentrations. Similar types of effects occur in plants under natural growing conditions although the sulfur dioxide level necessary to cause these responses may be different.

C. The statement in the summary that "agricultural crops are threatened by concentrations higher than those necessary to threaten human health" is in error and should read "... lower than those necessary to threaten human health."

R. You are correct. It should read "Agricultural crops may be threatened by concentrations lower than those necessary to threaten human health."

C. It is incorrect to say that there is no level of sulfur dioxide low enough to assure that no health or environmental effects will occur.

R. Numerous studies of health effects cited in the Draft EIS fail to indicate a clear lower threshold of effects. Studies of effects to ecosystems also reveal some measured effects at the lowest detectable levels. See especially pp. 69-70, pp. 91-92, and pp. 97-101.

C. Most experiments given in the draft EIS on the effects of sulfur dioxide on vegetation do not support the proposed standards.

R. The proposed sulfur dioxide standards would protect most Montana plant species. There are certain plants which might show some minor injury at the levels allowed by the standard.

C. The EIS has not included the results of a study conducted by Malholtra(1976) which indicates that present Canadian federal and provincial ambient air qualtiy standards for sulfur dioxide are quite effective in preventing permanent damage to lodgepole and jack pine trees.

R. The study by Malholtra was included in the draft EIS (see page 109). The experiment consisted of in vitro exposure of isolated lodgepole pine seedlings to aqueous sulfur dioxide. A relationship between aqueous and gaseous sulfur dioxide concentrations was assumed by the author. No experiments with jack pine were reported in the paper and no deductions between experimental results and Canadian or any other sulfur dioxide standards were presented.

C. A recent article (Chemical Week, February 21, p. 23) quotes TVA soil scientist J. C. Noggle, suggesting that plants need to ingest sulfur dioxide from the atmosphere as a nutrient.

R. While it is true that sulfur is an essential nutrient for plant health, it has not been proven that sulfur dioxide pollution is useful for this process in Montana. It is true that in areas with sulfur deficient soil, atmospheric sources of this element can encourage plant growth. No areas in Montana are known to have this type of sulfur deficient soils.

C. Adverse effects to vegetation from sulfur dioxide in combination with other pollutants (synergism) is overstated in draft EIS.

R. A number of studies, reviews, and testimonies speak to the contrary, emphasizing that sulfur dioxide does adversely affect vegetation at lower levels in combination with other pollutants than singly. Combination experiments presented in the draft EIS were at pollutant levels that have been recorded in Montana.

C. The draft EIS ignored an immense body of research pertaining to the effects of sulfur dioxide on vegetation. The most notable omission is several key reviews, the most recent of which was conducted by the National Research Council (NRC) (1978). The NRC document summarized all available information on long duration (growing season to annual or longer) by saying that the threshold concentration for effects of sufur dioxide on susceptible species is in the range of 0.10 to 0.23 ppm.

R. The NRC document did not become available for review by the Department until after publication of the draft EIS. After publication of the draft EIS, the document was reviewed for relevance to the proposal of sulfur dioxide standards. The analysis presented in the EIS uses many of the studies included in the NRC and other reviews. The NRC document makes no such conclusion regarding the threshold concentration of sulfur dioxide.

C. The draft EIS should consider the impact of sulfur dioxide levels on reclamation efforts in eastern Montana.

R. Effects such as these may prove significant in the future. To date no studies on this important subject have been attempted.

C. A study by Herbert Jones of the Tennessee Valley Authority reported little damage even to sensitive vegetation such as soybeans at ambient levels below the federal U.S. standards. This study was not cited in the draft EIS.

R. The literature citations concerning sulfur dioxide effects on vegetation in the draft EIS included original research papers or published manuscripts. The Jones paper cited above was not published. It was not possible to critically review the paper for content and it therefore was not included in the draft EIS.

C. The analysis of the impacts of sulfur dioxide to vegetation does not differentiate between injury and damage - the former indicating an adverse effect to the health of the plant, the latter referring to injury that prevents the economic use of the affected plant part.

R. The difference between injury and damage to vegetation is not clear cut. The degree of damage to vegetation depends on the measurement technique and upon what portion of the plant is harmed by the pollution. Plant scientists for many years thought there could be no economic damage to vegetation without visible injury symptoms. This has been proven false. There can be losses to growth and yield even without visible symptoms of injury. It was assumed in the draft EIS that with visible injury and the inhibition of certain internal plant processes lead to economic damage if allowed to continue, just as disruptions in human processes eventually lead to clinically diagnosed ailments after continued exposure to the pollutant. The objective of air quality standards is to prevent vegetation injury from becoming economic damage. Under all measurement methods plant scientists use, injury is viewed as a predictor of damage. The analysis of air pollutant effects to vegetation in the draft EIS uses the concept of injury similarly - as a predictor of economic and ecosystem damage.

C. The experiment of Costonis (1973) should not be used as a justification for the proposed sulfur dioxide standard. This experiment used extremely sensitive clones of eastern white pine which are not grown in Montana.

R. The experiment of Costonis (1973) was included in the discussion to illustrate the increased sensitivity of certain subclasses of plants within a given species to sulfur dioxide. Within the species of eastern white pine, Costonis (1973) found that certain trees showed needle damage from 0.05 ppm sulfur dioxide after a two-hour exposure. Berry (1971) on the other hand, found more typical trees of this species were damaged by 0.25 ppm sulfur dioxide after a two-hour exposure. Thus, these results show that within a given species of vegetation, differential response to sulfur dioxide is possible. This gives some explanation for the differential response noted by some researchers studying Montana plants.

C. Experiments cited in Table III A.III by Berry (1971) Houston (1974), MacDowall and Cole (1971), Applegate and Durrant (1969), Kress and Skelly (1977) that show adverse effects to plants from sulfur dioxide should not be considered in setting a Montana sulfur dioxide standard.* The plants affected do not grow in the state and would not be affected by the proposed standards.

R. A number of researchers have compiled classification schemes which rank North American and European vegetation based upon sensitivity to sulfur dioxide (Linzon, 1972; Scheffer and Hedgecock, 1955; Van Haunt and Stratman, 1969). These classifications result from field observations of relative plant damage around sulfur dioxide sources. They provide a method of categorizing different species of plants for comparisons of dose-response biochemical, and ecological effects. This allows prediction of what would be likely to occur with other plants in the same categories.

The plants evaluated in the studies listed in the above comment fall in the same sensitivity category as many Montana plants.

COMMENTS ON SULFATE AND ACID MIST

C. The EPA concluded in 1973 that there was not enough information to demonstrate that the possible effects of acid rain were related to ambient standards for sulfur dioxide. There is no clear relationship between acid rain concentrations and ambient sulfur dioxide standard for Montana.

R. The discussion presented in the draft EIS points out the potential effects of acid precipitation. Information to substantiate effects in Montana is not currently available. Although the relationship between sulfur dioxide standards and acid rain is not clearly drawn, it may be that further research will clear the situation.

C. The draft EIS discusses acid precipitation. However, the economic impacts of acid rain upon the health and welfare of Montana are not quantifiable, and no immediate adverse impacts on soil, vegetation, materials or aqueous systems has been demonstrated.

*The proposed sulfur dioxide standards are based entirely on human health effects. Review of the literature on vegetation effects indicated most plants would be protected by standards set to protect health. Studies on vegetation effects were cited to show this relationship.

R. The comment is correct in pointing out that no demonstrable effects from acid rain have been observed in Montana. The draft EIS attempted to analyze studies on the effects of acid rain in other parts of the U.S. and in Europe in order to point out the potential for ecosystem damage that could occur. The draft EIS made no clear cut predictions of acid rain problems in Montana and did not use the hyopthetical acid rain problem in developing recommended sulfur dioxide standards.

C. The draft EIS lacked an adequate explanation of its proposal to drop the sulfation plate and calcium formate paper methods of monitoring sulfur and fluoride. This matter should be reconsidered on the basis that the alternatives to these methods are costly.

R. The Department is not proposing to completely stop the use of either method. These methods have proven effective in determining relative concentrations of sulfur and fluoride pollutants in various areas. The Department will continue to use these methods for determining where to locate the more expensive monitors, the number of monitors necessary to adequately cover a given area, and as an indicator of trends. If "hot spots" are located, the Department will initiate monitoring procedures, outlined in the draft EIS, to determine if a violation exists. If there was a violation, then the appropriate control strategy would be required.

Both the sulfation and calcium formate plate methods of monitoring pollutants have been found to be less precise and accurate then standard reference methods (McAdie and Jones (1971); Robbins, (1979). Whereas standard reference methods are not influenced by pollutants other than those they are specifically designed to measure, sulfation plates and formate plates react to some extent with a variety of pollutants. The Department realizes that all areas of Montana have mixtures of pollutants with varying potentials to interfere with nonspecific air monitors, and that all areas have unique ratios of these interfering pollutants. Since the Department feels it is impractical to set separate standards for sulfation (for example) in each of these areas, standard reference methods with known reliablity and sensitivity have been deemed appropriate to measure the pollutants considered in this document.

COMMENTS ON THE HEALTH EFFECTS OF LEAD

C. No Montana data presented in the draft EIS shows interference with hemoglobin formation or reduced performance on intelligence tests from excessive blood lead concentration.

R. Scientific studies which document these adverse effects have been conducted in other parts of the U.S. It is reasonable to apply these studies to Montana, where similar exposure conditions are present, and where similar blood lead levels have been recorded.

C. The only measurable health effect likely to occur below 40 ug/dl is a subclinical change in certain components of the process of hemoglobin formation.

R. Changes in the formation of hemoglobin do occur below 40 ug/dl blood lead. This may lead to abnormally low levels of blood hemoglobin. Furthermore, intelligence tests suggest that children with blood lead levels of 35 ug/dl can have lower scores than children with lower blood lead levels.

C. The EIS offers no evidence of the relationship between lead in the ambient air and lead in the soil around East Helena. There also is no convincing evidence that reduction in ambient air lead would result in lower soil lead levels.

R. It is safe to assume that a reduction in ambient air lead concentrations would not cause a reduction in soil lead levels, at least in the short term. The fate of soil lead may be affected by land use and agricultural practices but prediction of these effects is beyond the scope of this EIS, and possibly immaterial. The Yankel et al. (1977) study clearly shows that it is necessary to have low air lead levels in areas of high soil lead to ensure a minimal risk of adverse health effects in sensitive populations.

C. The draft EIS cites only the lead toxological studies representing the most conservative extreme, to support the Bureau's predetermined conclusions.

R. Every attempt was made to present the most up-to-date literature in an unbiased manner. Studies showing effects at lower levels were emphasized. It was felt that this gave a better evaluation of the potential effects that could be anticipated at a given pollution level, and was in line with the Department's policy of erring on the side of caution where human health was being considered.

C. The draft EIS fails to consider what effects a more lenient lead standard would have on the sensitive component of the population (i.e. above 1.5 ug/dl).

R. Table III B.III on p. 122 gives one an idea of the implications of various lead standards with respect to children. In short, higher lead standards would increase the probability that a greater percentage of the children at risk would have 40 ug/dl blood lead and hence a greater percentage of children would have an increased risk of lead poisoning. The effects of alternative lead standards on other sensitive components of the population (i.e. the unborn) cannot be derived from this table.

C. Application of Yankel _et al._ is inadequate to justify this proposed lead standard. Montana studies do not corroborate Yankel _et al._'s theoretical results.

R. Use of the Yankel _et al._ equation allows calculation of the number of children that would exceed 40 ug/dl blood lead at given air and soil lead levels. At the air and soil lead levels recorded in East Helena, ten percent of the children would be predicted to exceed a blood lead level of 40 ug/dl. Eden (1977) found that seven percent of East Helena children tested for blood lead exceeded 40 ug/dl. Considering that during the sampling there was snow on the ground to minimize exposure from the soil, theoretical and recorded values correspond well.

C. The draft EIS says children are the most sensitive portion of the population to adverse health effects from lead, and that children's blood should not exceed 40 ug/dl of lead. Furthermore, the EIS says the proposed lead standard would allow eight percent of the children living in areas of high soil lead to exceed 40 ug/dl. It is therefore not a protective standard for human health and should be made more stringent.

R. The statistical technique used in the formulation of a lead standard should not be viewed as indicating that an event is certain to occur at a given air lead level. It predicts that increasing air lead levels pose a greater risk that children will exceed 40 ug/dl blood lead just as lower air lead will decrease the risk.

The 40 ug/dl blood lead level found to be associated with the onset of anemia and lower intelligence test scores in children signifies that the risk of adverse health effect increases above 40 ug/dl blood lead and decreases below it.

The standard reflects a consideration of these two statistical facts that a child will exceed 40 ug/dl blood level at certain air lead levels and therefore be more vulnerable to adverse health effects. The product of multiplying probabilities results in a smaller chance of the two events happening simultaneously. The use of the highest East Helena soil lead level (4000 ug/g) in the Yankel _et al._ (1977) equation adds a level of protection to the recommended standard of 1.5 ug/m^3. By reducing to eight percent the possibility that children living in the highest soil lead areas would have 40 ug/dl blood lead, the standard assures there is a low risk to the children who live in high soil level areas, and a still lower risk to those in low lead areas.

C. The analysis of an adequate air lead standard based on Yankel et al. (1977) did not take into account all parameters used in the study.

R. The analysis used as a basis for the standard depended on an equation developed by Yankel et al. It was based on average values compiled from the authors' data. The use of the equation was considered justifiable by Yankel et al. and by the Bureau since it represented "average household" level exposures.

C. Toxic effects to vegetation from excessive lead was not proved in the draft EIS and should not be a basis for the standard.

R. The most significant effect lead has in respect to vegetation is the indirect effect that results when animals or humans consume lead contaminated foodstuffs.

C. Studies cited in the draft EIS do not prove that children near smelters have higher blood lead levels than those away from such lead emitting sources.

R. This is correct. The studies cited do not prove this, but provide strong evidence suggesting such a conclusion.

C. The proposed lead standard is unnecessarily stringent in light of the small area affected by excessive soil lead.

R. The proposed lead standard is based on an air quality level thought to be protective of human health under the most adverse environmental conditions. The towns of East Helena and Anaconda have high soil lead and a substantial number of vulnerable young children. The proposed lead standard would protect these children from the lead in the environment of these cities.

C. Elevated ALAD and EP levels do not indicate adverse human health effects from lead exposure.

R. Elevated EP signifies a disruption in normal biochemical processes. The Center for Disease Control (CDC) considers elevated EP to be an "indicator of the risk of lead poisoning. ..." Elevated ALAD sometimes but not always indicates adverse health effects from lead exposure.

C. The draft EIS refers to the Center of Disease Control (CDC) study as setting 30 ug/dl as the level indicating the onset of lead poisoning in children.

This statement is misleading since the CDC report says 30 ug/dl is the cutoff point for the prevention of lead poisoning.

R. The CDC guidelines define the onset of lead poisoning as 30 ug/dl blood lead associated with an EP (a substance whose concentration in the blood indicates a disruption of normal hemoglobin production) level greater than 109 ug/dl and not simply a blood lead level of 30 ug/dl as the draft EIS states.

C. The draft EIS implies that East Helena air lead concentrations can have health effects on intelligence and hemoglobin levels, but there is not one reference to any actual health effect in Montana.

R. Ambient lead standards are not necessarily set after adverse health effects occur, and should be set when scientific information indicates a threat of such effects. The presence of such a threat has been indicated for East Helena as shown in the draft EIS.

C. The draft EIS does not prove that blood levels less than 40 ug/dl cause decreases in children's performance during intelligence tests.

R. Page116 of the draft EIS cites the work of Needleman et al. (1978) which showed a significantly lower performance on intelligence tests by children with 35 ug/dl blood lead than those with 24 ug/dl.

C. Dr. Panke in his testimony before the EPA considering the setting of a federal ambient lead standard stated that a study conducted near a Kellogg, Idaho lead smelter found that children with 40 to 80 ug/dl blood lead had no clinical adverse effects. Thus, even blood lead levels in excess of 40 ug/dl may not result in any adverse effects on health.

R. In view of the research results now available, the Department takes the position that the threshold for reduced hemoglobin begins at 40 ug/dl blood lead. The proposed standard is intended to reduce the risk of children acquiring this threshold level of blood lead.

C. The draft EIS does not point out that blood lead levels may vary substantially even in populations that have no elevated exposure to lead. In fact blood lead levels of East Helena children were similar to those in other children in Montana living away from industrial sources of lead. The process used in the draft EIS to relate ambient air measurements to blood lead levels has uncertainties to which the draft give only superficial treatment.

R. It is true that there are uncertainties in determining air lead-blood lead relationships. Nonetheless, certain trends are discernible. Montana's blood lead study cited on page 120-121 of the draft EIS shows that the percentage of children with elevated blood lead was decidedly greater near ambient lead sources than in areas away from such influences.

COMMENTS ON NONHEALTH EFFECTS OF LEAD

C. Lead accumulations in crops, cattle, and ecosystems should be considered in setting the lead standard.

R. A relationship between air lead levels and effects on crops, cattle, and ecosystems would be necessary before a standard based on these effects could be proposed. Furthermore, there should be economic analysis of these welfare effects before a welfare standard could be set. Such analyses are not available for evaluation of the nonhealth impacts of lead.

C. Lead effects on animals and ecosystems are not significant and should not be used as a basis for the proposed standard.

R. The draft EIS cited several studies which found lead poisoning in farm animals near East Helena. The owners of the animals considered this to be a serious effect.

GENERAL COMMENTS ON LEAD

C. May it not be correct that lead emissions from cars will not decrease as a greater percentage of cars on the road use leadless gasoline?

Increasing percentage of cars using non-lead gas does not necessarily mean that the total number of cars using leaded gas will decrease.

R. The future of the automobile and transportation industries is too hazy to allow reliable predictions of how much lead might be emitted into the environment by automotive sources.

C. The draft EIS fails to acknowledge that cars may be the greatest source of lead emissions in may areas.

R. The federal government is reducing lead emissions from automobiles by requiring nonlead fuel in new cars. It is true that in certain large urban areas lead emissions from cars may continue to be a problem.

COMMENTS ON CARBON MONOXIDE HEALTH EFFECTS

C. The draft EIS says the effects of carbon monoxide may increase with altitude, yet the standard is determined by reference to a table based on sea-level conditions. Can this table be recalculated at an elevation relevant to Montana?

R. Not all the interactions between blood carboxyhemoglobin and altitude are well understood. Within the limits of this understanding, Table III-C-1 has been recalculated for Billings (3100 ft). Billings was chosen rather than Butte, because there is no clear problem with carbon monoxide concentrations in the higher elevation cities of Montana. The procedures and data for the calculation are taken from Miller (1975), Smith (1975) and Hurtad (1964). The changes from sea level are quite small. This is partly due to the decision by the Department to express the standard in parts per million. This unit base does not need to be changed with altitude. The units of the federal standard (mg/m^3) change dramatically with altitude solely as a function of prevailing air pressure and without reference to any physiological effect. The table below assumes an adult female acclimated to sea level. A resident of Billings would show less response.

AMBIENT CARBON MONOXIDE LEVELS AND ASSOCIATED CARBOXYHEMOGLOBIN IN PERCENTAGE AFTER 1 HR AND 9 HR EXPOSURES

Percent Carboxyhemoglobin	Resting 1 hr	Resting 8 hr	Moderate Exercise 1 hr	Moderate Exercise 8 hr
1.5	21 ppm	9	15 ppm	9
2.0	34	12	23	12
2.5	47	16	31	15

The small anomaly between the results in this table and the original table is partly due to the use of a slightly more accurate method of computation for this table.

COMMENTS ON THE HEALTH EFFECTS OF NITROGEN DIOXIDE

C. The Shy <u>et al</u>. (1970a, 1970b) studies conducted near Chattanooga, Tennessee are used to support an annual nitrogen dioxide standard. These and other epidemiological studies cited in the EIS do not support development of a quantitative dose-response relationship. There is a need for clinical and animal studies to establish an adverse effects threshold.

R. Animal and clinical studies are deficient in their ability to quantify adverse health effects from nitrogen dioxide for long-term exposures. Epidemiological studies most accurately define such effects and were therefore used to justify the annual nitrogen dioxide standard.

C. The effects noted in the Von Nieding _et al_. (1977) study are difficult to determine because a combination of air pollutants was used rather than nitrogen dioxide alone. Furthermore, nonstandard measurement techniques were employed.

R. The work is suggestive but not conclusive.

C. The epidemiological studies cited in the draft EIS for an annual nitrogen dioxide standard have all been severely criticized and are therefore invalid as evidence for Montana's proposed annual standard.

R. Calculations in the draft EIS were based on a re-interpretation of the air monitoring results in the Chattanooga studies. This re-evaluation overcomes the previous criticisms of the studies.

C. The need for a one-hour standard for nitrogen dioxide is questionable. It is best to wait until the EPA proposes a one-hour standard and adopt it.

R. Work cited in the draft EIS indicates that short term exposures to nitrogen dioxide cause adverse health effects in experimental animals and humans. It is apparent that such a standard is needed. However, there is not a large body of scientific evidence with which to establish such a standard. The proposal is based on results which resulted from multiple exposures at a particular level of nitrogen dioxide. A one hour standard was developed to reduce the occurrance probability of these multiple exposures.

C. The Orehek _et al_. (1976) study cited in the draft EIS used an extremely sensitive test of adverse effects from exposure to nitrogen dioxide. This together with the minimal response noted in the results of the study do not provide conclusive evidence of significant adverse effects attributable to nitrogen dioxide.

R. The Orehek _et al_. (1976) study is important because it shows that nitrogen dioxide at concentrations as low as 0.11 ppm with an exposure period of an hour may exacerbate health problems in sensitive individuals. The study's significance to normal populations is unknown.

C. Odor and dark adaptation of the eye may or may not be considered adverse effects. The use of experiments with such effects is of doubtful utility.

R. Comment noted.

C. The experiments with animals mentioned as justification for a one-hour nitrogen dioxide standard involved long-term continuous exposure to static levels of nitrogen dioxide, a situation not found in the ambient atmosphere. Thus, this information cannot justifiably be applied to the setting of a short-term standard.

R. The animal studies referred to in the above comment consisted of static and intermittent exposures to nitrogen dioxide. They suggest that repeated short-term exposure to nitrogen dioxide can cause increased mortality when test animals are simultaneously exposed to bacterial infection.

These studies in conjunction with observations indicating the possibility of increased colds in children and sensitive tests indicating increased attacks in persons with asthma suggest the need for a one-hour nitrogen dioxide standard. The intent of a one-hour nitrogen dioxide standard is to reduce short-term exposures to a level where repeated exposures do not aggravate exising health problems or initiate disease in sensitive persons.

C. The Vosin *et al.* (1977) study found a decrease in the activity of lung macrophages exposed *in vitro*. Because the applicability of *in vitro* experiments to the human body is unclear, less weight should be accorded these results in the standard setting process.

R. *In vitro* experiments are useful in defining the mechanisms causing an observed effect. The Vosin *et al.* study was not used to quantify an exposure level necessary to cause antibacterial cell destruction but rather to describe the mechanism behind the increased mortality noted in bacterially infected rats after exposure to nitrogen dioxide (Coffin *et al.* 1976; Ehrlich and Henry 1968).

C. The draft EIS misleads the reader when it says that nitrogen dioxide in concentrations occasionally recorded in Montana has been shown to adversely affect human health. It is unclear whether human health was affected in Montana or elsewhere in the country.

R. Nitrogen dioxide levels occasionally recorded in Montana are as high as those which have been established through scientific inquiries to cause adverse health human health effects in other places. Although there is no research to determine whether such effects occur in Montana, there is no reason to believe that the people of Montana are less vulnerable than other people.

C. The infection susceptibility studies cited in the draft EIS are valid but there are a number of studies not included in the document that indicate adverse impacts at much more concentrated levels. Thus there appears to be a split in consensus as to what levels of nitrogen dioxide are necessary to cause infection susceptibility. The draft EIS does not describe the split in scientific opinion on this subject.

R. The draft EIS did not include all experiments on the relationship between increased mortality due to nitrogen dioxide and increased infection susceptibility. The emphasis was on experiments which showed results at relatively dilute concentrations. Experiments showing results at stronger concentrations are of little use in determining what levels are safe.

C. The "Gas Stove" studies cited in the draft EIS have many problems. The Melia et al. (1977) study for instance overlooked many variables which may have affected the observed illness rates noted in the study. Furthermore, the authors did not measure nitrogen dioxide levels during the study. It is quite possible that even if nitrogen dioxide could be associated with increased respiratory illness in English homes, levels of nitrogen dioxide may be quite different in U.S. households.

R. The Melia et al. (1977) study accounted for many variables which might have affected respiratory illness rates in children from electric stove and gas stove households. The study design found that illness rates were independent of age, social class, latitude of residence, population density, family size, crowding in the home, outdoor levels of smoke and sulfur dioxide and the type of fuel used for heating the home. Cigarette smoking was not considered in the analysis but a known relationship between social class and smoking allowed this variable to be taken into consideration. The Melia et al. (1977) study establishes a strong causal relationship between increased respiratory illness in English children and gas stove use in their home. Melia et al. (1978) subsequently measured nitrogen dioxide levels in households with both gas and electric stoves and found that gas stoves produced a level of approximately 0.07 ppm nitrogen dioxide for the 96 hours of air monitoring.

Experiments by Wade et al. (1975) and Palmes (1977) have sampled nitrogen dioxide levels in American homes with gas stoves. The Wade et al. study reported nitrogen dioxide levels similar to those Melia et al. found in English homes. Palmes (1979) reported a lower level than found in English households. The Wade et al. (1975) experiment found that two hour average nitrogen dioxide levels in American homes with gas stoves were 0.15 ppm. This may be the best estimate of short-term exposures experienced by individuals in these households.

C. Synergism between sulfur dioxide and nitrogen dioxide has not been demonstated at low concentrations under field conditions.

R. If low concentrations mean at or below federal ambient air quality standards, that is correct.

C. The authors of the EIS had the same health information base the federal government had in deriving a one-hour oxidant standard. Yet the authors of the EIS arrived at different conclusions as to an acceptable standard and margin of safety. The new federal ozone standard of 0.12, one-hour average, was judged by a large staff of health professionals to be adequately protective of public health.

R. EPA has adopted a new one-hour ozone standard of 0.12 ppm. However EPA's initial determination of June 1978 was that a 0.10 ppm standard was necessary to provide an adequate margin of safety. Later EPA changed its conclusion although the EPA Advisory Panel on Health Effects recommended retaining the original 0.08 ppm standard.

The Department's proposed standard of 0.10 ppm is based upon consideration of scientific evidence and on an assessment of the risks to human health associated with this pollutant.

C. The draft EIS erroneously states that subjects in the Delucia and Adams (1977) study experienced decrease in lung function when engaged in moderate exercise at 0.15 ppm ozone. Rather, these results were found when individuals engaged in steady heavy exercise and not at moderate exercise levels. The draft EIS also fails to say that this experiment used a small group of subjects and has not been repeated.

R. The Delucia and Adams (1977) study represents the current state of knowledge on ozone effects in humans. It has not been replicated to date. The results showed discernible but not significant changes in respiratory patterns at 0.15 ppm ozone under conditions of the study. The level of exercise cited by the authors is "moderately severe aerobic workloads." This represents 65% of maximum exercise potential in the subjects. The Delucia and Adams (1974) study indicates that exercising individuals are most sensitive to ozone. This is in line with the general trend found by Hazucha et al. (1973) and Hackney et al. (1975).

C. The Wayne and Wehrle (1969) study on reduction in athletic performance from oxidants and used to justify the proposed standard is inconclusive. Contrary to what the EIS said, oxidant levels were not related to a decrease in performance below 0.10 to 0.15 ppm.

R. The Wayne and Wehrle (1969) study cited in the comment was not used in the EIS. The study does not deal with decrements in athletic performance from airborne oxidants. The Wayne et al. (1967) study cited in the EIS does discuss this topic. The study was used to illustrate that oxidant

impacts on humans are more serious when the individual is engaged in exercising. Evidence obtained in clinical experiments conducted by Folinsbee (1975, 1977) and Delucia and Adams (1977) indicate that ozone is most probably the oxidant component responsible for results obtained by Wayne et al. (1967). Furthermore, the Delucia and Adams Study indicates that reductions in athletic performance are accompanied by chest discomfort and lung function reduction at 1-hour ozone levels of 0.15 ppm.

C. The Hammer et al. (1974) student nurse study measured oxidants rather than ozone. The study is not, as the EIS states, an indicator of eye irritation and headache at 0.15 ppm ozone. Researchers agree that eye irritation is caused by other components of the oxidant mix such as peroxyacetylnitrate, acrolein, or formaldehyde, and not ozone. Headache was also a complaint in the study. Examination of the data reveals that rates of headache were not unequivocally elevated below maximum hourly oxidant levels of 0.30 to 0.39 ppm (EPA, 1978).

R. It is correct that other components of measurable oxidants cause eye irritation at lower levels than ozone does. This was discussed on page 163 of the draft EIS. Measurements of oxidant mixtures generally show that measureable oxidants consist primarily of ozone. The Hammer et al. (1974) study was used in this context, i.e. that oxidant measurements recorded in the study were largely ozone.

The symptoms of headache observed in the study showed a consistent increase of three to eight percent at oxidant levels of 0.00 to 0.29 ppm, above which the excess increased greatly. The oxidant level where headache symptoms began averaged 0.05 ppm with an upper and lower statistical range of 0.0 ppm to 0.19 ppm. The Hammer et al. (1974) study suggests that components of oxidant pollution cause the onset of health effects without a definite threshold limit. The implication is that ozone is partly responsible for the no threshold adverse effects. From the study data, it is not possible to define precisely the ozone level responsible for the observed effects.

C. Major amounts of ozone may result from the photochemical action of the sun on large quantities of hydorcarbons generated from natural sources such as trees.

R. Such reactions have been observed in various places, but there is no indication they have significant effect in the portions of Montana where significant levels of ambient ozone are found in the summer.

C. The discussion of Schoettlin and Landau (1961) presented in the draft EIS does not give the proportion of individuals with asthma in any exposure category, only that asthma attacks were statistically greater on days when hourly oxidant levels were above 0.25 ppm. It is not possible to know from this study whether attacks were more prevalent below 0.24 ppm oxidant. The study further states that attacks coincided with elevated oxidant levels in 9 of 137 patients studied. The study also did not define what role ozone had in causing the attacks.

R. Attacks were most often correlated with increasing oxidant levels in 8 of 137 study subjects. A correlation of 0.37 was noted between increasing oxidant levels and increased asthma attacks in all subjects interviewed. Attack rates were not found associated with other measured pollutants or environmental variables. The authors noted that asthma attacks were no more frequent at 0.13 ppm. From this, they deduced an attack threshold between oxidant levels of 0.13 and 0.25 ppm.

It is true that the asthma attacks observed by Schoettlin and Landau (1961) cannot be proved to result from elevated ozone levels. However, based on clinical evidence of ozone induced attacks in individuals with asthma (Linn et al. 1976) and increases in an epidemiological study by Kurata et al. (1976) the suggested association seems reasonable.

C. The EIS incorrectly says Bartlett et al. (1974) found 0.02 ppm of ozone to cause increased lung volume in rats. The actual concentration stated in the Bartlett et al. (1974) study is 0.2 ppm ozone.

R. Thank you for pointing out the error.

C. The Von Nieding et al. (1976) study cited in the draft EIS found detrimental lung changes occurred in healthy subjects after a 2-hour exposure of 0.15 to 0.25 ppm ozone. This study's results should be viewed with caution since the nonstandard measuring techniques used in the study have not been verified by other researchers.

R. The techniques used in Von Nieding et al. for measuring air resistance for arterial oxygen tension are common in Europe, but not in the U.S. The methods are not inaccurate nor hypersensitive, just different. The study needs confirmation. Nonetheless it is important in understanding the possible adverse effects at levels lower than previously described in the literature.

C. The draft EIS says that Hazucha et al. (1973) found changes in lung function after two hours at 0.25 ppm ozone. The draft EIS does not mention that Hackney et al. (1975) found in a similar type of experiment that such effects occurred in excess of 0.37 ppm ozone but there was no effect at 0.25 ppm. The EIS does not discuss this contradiction of the Hazucha et al. study and therefore provides a biased picture of the actual effects level for ozone.

R. It is true that the Hackney study failed to find results similar to those observed by Hazucha et al. (1973). Hazucha et al. experimented with Canadians in Montreal while Hackney et al. studied Los Angeles residents. The contradiction between the studies was partially explained in a subsequent study conducted by Hackney et al. (1977) in which Montreal and Los Angeles subjects were tested together. The experiment showed that the

Canadians were more sensitive to ozone than the Los Angeles residents were. Environmental effects were ruled out as a contributor to the difference in subject sensitivity. The hyopthesis suggested by reviewers of the more recent Hackney study is that the Los Angeles subjects have become acclimatized to higher ozone levels while Canadians have not, and thus are more sensitive.

The Hackney et al. (1977) study lends support to the Hazucha et al (1975) that a 0.25 ppm ozone two hour exposure can affect human health in sensitive individuals. The higher tolerance of Los Angeles subjects is not without consequences. Freeman et al. (1974) found that long term breathing of ozone causes premature aging in rats. Long term effects have not been determined in humans but a similar effect is plausible. Montanans are much more like the Canadian subjects in that they have not been exposed to elevated ozone. It is clear that Montanans constitute a sensitive portion of the general population and that Hazucha's results are more germane than Hackney's in setting a Montana ozone standard.

GENERAL AND NONHEALTH COMMENTS ON OZONE, CARBON MONOXIDE AND NITROGEN DIOXIDE

C. The proposed ozone standard would not protect vegetation.

R. One study cited in the draft EIS recognized adverse effects to vegetation below the proposed standard (Bennett and Hill, 1974). The plant response consisted of a reduction in apparent photosynthesis, which returned to normal following exposure. Other experiments with longer exposures may not be applicable because of the short period of time in Montana when the potential for ozone generation is high. Under sensitive experimental protocol, Tingey (1971, 1973) found plant damage at ozone levels at or below the proposed ozone standard in combination with sulfur dioxide. These experiments are not necessarily indicative of the ambient situation. They do, however, suggest the potential for some ozone damage at levels below the standard when large amounts of other pollutants are present.

C. The proposed standard for ozone is stricter than the recently revised Federal EPA air quality standards; Montana should follow the EPA and propose an identical ozone standard.

R. The federal government specifies that the standards it adopts are the minimum acceptable, and states clearly retain the right to adopt more stringent standards (p.3 draft EIS). The proposed Montana standard is not excessive. It is based on a clearly defined threshold level and a moderate margin of safety.

C. The rationale used to justify the one-hour ozone margin of safety is faulty. It is based on the potential for ozone production in Montana rather than on the scientific knowledge of the pollutant.

R. The margin of safety used to justify the proposed ozone standard is consistent with the explanation on p. 15 of the draft EIS regarding the setting of a margin of safety: "The margin of safety used for any given pollutant depends primarily on the seriousness of the danger from that pollutant. . . ." The margin of safety of 1.5 is based on a 0.15 ppm threshold level for adverse impact in humans. Recognition of the threshold at this level is justified by scientific studies indicating clear cut health effects. The sound understanding of the effects caused by various concentrations of ozone allows a lower margin of safety than is necessary with more vaguely understood pollutants.

A 1.5 margin of safety is feasible because conditions are not conducive to ozone production in Montana. One of the purposes of a margin of safety is to avoid abnormally high concentrations caused by unusual meteorological conditions. The lower sun angle at these northern latitudes makes it much less likely that such events will occur. Furthermore, the lower energy in the sun's rays reduces the potential for ozone production so the total exposure over the course of a year is much less than in an area like southern California where ozone is more easily produced.

C. The proposed one-hour standard for carbon monoxide would unduly hamper the transportation planning process and could create significant social and economic impacts.

R. The MAAQS analysis of air quality data indicates that the only places in Montana not in compliance with the proposed 1-hour carbon monoxide standard also are not in compliance with the proposed eight-hour standard. The changes necessary to reach compliance with the eight-hour standard should also reach compliance with the one-hour standard.

C. The impact statement should make it clear that the one-hour and eight-hour carbon monoxide standards will only be applied where people could be expected to be exposed for one or eight hours respectively.

R. Correct.

C. The choice of a safety factor of three in determining the one-hour nitrogen dioxide standard has not been justified in the EIS.

R. A change has been made in the proposed one-hour nitrogen dioxide standard. This final EIS discusses the margin of safety that was used.

C. The proposed one hour and annual nitrogen dioxide standards would not protect vegetation from damage, particularly when other pollutants also were present.

R. It is unclear whether vegetation would be completely protected by the nitrogen oxide standards proposed in the draft EIS when other pollutants were present. Experiments presented on page 79 of the draft EIS show that photosynthesis was reduced in plants when they were fumigated with nitrogen dioxide and sulfur dioxide at concentrations more dilute than required by the proposed standards. A reduction in photosynthesis does not indicate plant injury but indicates a physiological disturbance that could cause damage if continued. Damage to cultivated or native Montana plants has not been recorded at concentrations within the proposed standards.

C. Responses of vegetation to nitrogen dioxide in combination with other pollutants was not discussed in the draft EIS.

R. The draft EIS (p. 79-83 and p. 154) cites several studies on this subject.

C. There appears to be insufficient justification of a 0.10 ppm ozone standard. Montana should wait until the EPA has completed its review of the ozone problem before promulgating any standard.

R. The EPA has formally relaxed the federal ozone standard from 0.08 ppm to 0.12 ppm. The change came after an analysis of the total amount of time the average citizen would be exposed to this level of contamination. The Montana standard was based, not on the level of effect allowed to occur for a given time in individuals, but on the level of known adverse health affects with a margin of safety. The 0.10 ppm ozone standard proposed for Montana is more restrictive than the federal standard.

C. The use of a large safety factor for the carbon monoxide standard implies that Montana has more concentrated populations than the rest of the nation. Obviously this is not true. How will the standard be enforced since it's primarily produced by cars and trucks.

R. The choice of a standard does not depend on the absolute number of people who live near the pollution, but on the presence of any sensitive group within the population. Statistics from the National Center for Health Statistics (1973) indicate very little difference between Montana and the nation as a whole on this score. The final proposed standard uses less of a margin of safety than was included in the proposal in the draft, in part because of a re-evaluation of the uncertainty involved.

The cities that show violations of the standards will work to achieve the standards through the State Implementation Plan. If present control efforts fail, it may be necessary to begin a limited program of inspection and maintenance, to find those cars that are emitting more carbon monoxide than their factory specifications permit. In a few areas, another major source of carbon monoxide is improperly used wood stoves. If insufficient air is brought to the fire, the stove can coke the wood, releasing substantial quantities of carbon monoxide and losing significant amounts of heat in the exhaust.

C. Use of heated nephelometer doesn't take into account water vapor and steam which are common in Missoula.

R. The heated inlet substantially reduces the effects of high humidity on visibility. High humidity can react with particles in the air to reduce visibility. Thus the nephelometer tends to understate the visibility degradation in high humidity area.

C. The proposed visibility standard, is equivalent to an annual average visibility of 70 miles, yet the observed visibility is 41 miles at Kalispell, 60 miles at Billings, and 65 miles at Great Falls.

R. These visibility averages should not be assumed to convert directly into an annual average extinction coefficient for several reasons. First, the equations on page 185 of the draft EIS cannot be used to convert next to the average visual range (the average of 1 divided by x is not the same as 1 divided by the average of x). The relation between averages is complex and depends of the statistical distribution of the measurements. Second, the visual range readings that will be obtained from an integrating nephelometer operated as described in the rule will differ due to the requirement for green light sensitivity and the use of a heated inlet tube. The specification of green light sensitivity will increase the constant in the equation on page 185 from 2.44×10^{-3} to 2.66×10^{-3} per meter. The heated inlet tube will heat the sampled air by about 5° to $15^{\circ}C$. This will reduce the measured b_{sp}.

If only the drier days are counted in determining the visibility, about five to sever miles should be added to the average visibility in Billings and Great Falls. The lower figure for Kalispell is due, in large part, to the more adverse weather conditions there. One of the primary reasons for choosing the integrating nephelometer is that it is much less affected by the weather than are visual observations.

The visibility standard as now proposed would only apply within Class I Prevention of significant deterioration (PSD) areas. The thirteen areas presently designated Class I in Montana are generally pristine, unpopulated and unindustrialized (see map on p. 5). Visibility in these areas may be assumed to be much better than in found in Kalispell, Billings or Great Falls.

C. If absorption is included in the visibility calculation, the approximate visibility equivalent to the proposed standard is perhaps 60 miles, but it is not possible to know exactly.

R. It is just because of such problems with interpreting the meaning of the various terms that a visibility measuring method specific to particle

scattering was selected. If a uniform statewide standard is to be imposed, such variables as absorption must be isolated.

C. The EIS summary says that the visibility standard cannot be exceeded more than once a year. Yet in the proposed rule it is defined as an annual standard.

R. The rule is correct. It is an annual arithmetic average, not to be exceeded.

C. The draft EIS fails to discuss the mechanism for the production of sulfate aerosols, one of the main sources of visibiltiy obscuring particulate.

R. This was discussed on p. 50 of the draft EIS.

C. Visibility should be stated in terms of human observers since it is the human perception that should be protected. At the very least it should use a telephotometer, which is a long-path measuring instrument.

R. The Houston air pollution control agency has attempted a program of visibility measurements with human observers. It had severe problems in locating appropriate sight paths with good visual objects, in getting readings made on a continuing and reliable basis, in getting any readings in inclement weather, and in keeping a stable pool of observers. As a result, it has had difficulty in producing useful data. As a general rule visibility will be limited by water vapor when humidities are high, so little useful data can be obtained by observation on these days.

Multicontrast telephotometers are only a slight improvement in that they eliminate the differences in readings that frequently occur between two observers at the same spot at the same time. However, the models now commercially available require a trained operator to take each reading and cannot be used under severe weather conditions. They are especially difficult to use properly when there is snow on the ground or the sky is partially overcast. While they are interesting and useful research instruments, they are not appropriate for use in defining a long-term air quality standard.

C. The draft EIS does not adequately define visibility. Visibility results from psychological interpretation of signals from the human eye and so defies definition and measurement.

R. This is precisely why there was no attempt to state the standard as visual range. The "average man" who would agree with the mathematical definition

probably does not exist. Visibility is a well defined and easily measured physical concept. It is possible to state a rough equivalence between visual range and the light scattering under certain conditions that are frequently met in Montana. This is described in detail in the draft EIS.

C. The nephelometer measures light scattering at a single point, but visibility involves the ability to see across great distances. To properly compute the visual range from a nephelometer you must assume the scatter coefficient is constant along the entire sight path, which may be 40 to 60 miles.

R. Although the loss of dramatic vistas of far away mountains may raise some of the most emotional responses to a reduction in visibility, the problem is equally serious over short distances. The view over short distances may not be entirely obscured, but is definitely degraded; a view of objects only three miles away will be affected when the visual range is still thirty miles. Thus it is misleading to speak of visibility only in terms of the grand vistas and to suggest that visibility measurements should span great distances. All other air quality measuring instruments measure conditions at a single point.

C. The standard does not contain necessary details. It does not make clear if the annual average is geometric or arithmetic. It does not describe the response curve of the photocell nor does it make clear if a heated inlet tube is used.

R. All the annual average standards in the proposed rule are based on arithmetic averages. The use of a green spectral response (or equivalent correction) and a heated inlet tube was stated in the revised proposed rule.

C. Otis, _et al_. erred in saying that Letimer _et al_. found an improvement in visibility in Billings during the industry wide copper strike in 1967-1968. In fact, they found just the opposite.

R. You have been misled by a typographical error in Latimer _et al_. Douglas Latimer explained to the Department that the curve for 1967-1976 was mislabeled in his report.

C. The draft EIS does not review and analyze the various methods for measuring visibility.

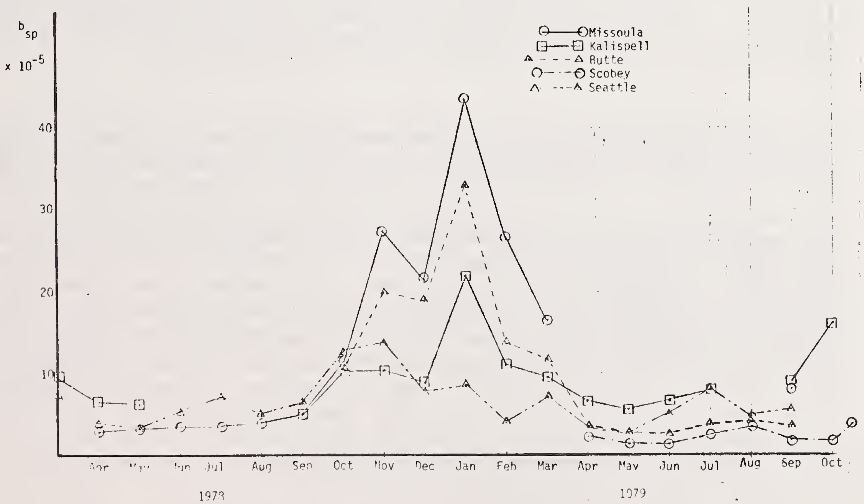
R. The draft EIS does not review and analyze the various methods for measuring any of the pollutants. The standard is stated in terms of the specific

measuring technique that is believed to give the most accurate measurement of the pollutant. The working paper section on visibility contained an extensive discussion of the primary measuring techniques, since no decision had been made on the most efficient way to measure visibility at that time. After a careful review, the Department concluded that the nephelometer is the only instrument realistically available for visibility related measurements under the conditions required for an ambient air quality standard.

C. What is the present status of visibility in Montana? The draft EIS contained only sketchy information.

R. Since the draft EIS was published, additional information has become available. As part of three special studies, nephelometers were set up in Butte, Missoula, Kalispell, and Scobey. The data are shown in the figure below. The figure shows that elevated readings occur during the fall and winter months, and in particular, January. The average for Butte, Missoula, Kalispell, and Scobey is 10.5, 14.2, 9.5, and 2.2 x $10^{-5}/mb_{sp}$. This data has been corrected for a green spectral response.

It must be noted that the visibility standard now proposed applies only to class I areas. None of the areas for which data is provided is a class I area. The Scobey area, however, is rural/agricultural area and may be representative of the Medicine Lake Class I area. The Scobey data to date suggests that it will be within the proposed visibility standard.



C. Only the top of a mountain 60 miles away can be seen (since the earth curves away). Thus the visible path is not through the air next to the ground, but through the cleaner air higher in the sky. Further, the air in and around the city is always dirtier than the air in the countryside, so measurement of the particle scattering coefficient in the city does not properly represent the visibility all along the sight path to the mountain. A scattering coefficient mathematically equivalent to, for example, 70 miles visibility in the city might only be observed when the air in the adjacent countryside is at 100+ miles visibility. Preservation of 60 miles visibility is possible only with a standard set much higher than $2 \times 10^{-5} m^{-1}$.

R. If only grand vistas over long distances are to be considered, and if all the measurements are made in the city centers, the comment is correct. The standard is intended to protect both the quality of nearby views and visibility in rural areas. It may be argued that for nearby views, a visibility of, say, 40 miles is adequate to protect the essential quality of these images. If the sight path through the city is only one-fifth of the total sight distance and the scattering coefficient in the remainder of the sight path is one-third that in the city, then a standard of $4 \times 10^{-5} m^{-1}$ would insure a distant vista visibility of approximately 70 miles and a nearby view visibility of slightly more than 40 miles. This calculation assumes that the absorption coefficient is approximately 20% of the scattering coefficient in the urban area and zero outside. Where the fine particles tend to be black the predicted visibilities would be less.

C. The draft EIS did not discuss the sources of the particles that degrade visibility. How much of it is from industry, from slash burning, from wood-burning fireplaces, from dust stirred up by agricultural operations, from the hydrocarbon emissions of forests, or even fog?

R. As the draft EIS explained, the very small particles are the primary cause of visibility degradation. These particles are generated primarily by the conversion of sulfur dioxide to sulfate in the atmosphere and from combustion. Slash burning and efficient wood-burning stoves could be a major source of fine particles. Dust from agricultural operations is primarily large particles which only interfere with visibility when there are enough to be a dust cloud or a dust storm. The importance of forests in generating hydrocarbons has been much overstated in the past and is still poorly understood. The relative strength of these various sources of particles is not now known for specific areas in Montana. If the history of other standards is any indication, the establishment of a standard for visibility is likely to generate studies of the relationship between these, and other, sources and visibility data while without a standard this will remain as unknown five years from now as it is today.

C. The EIS fails to demonstrate that there has been any significant reduction

in visibility in Montana or that such degradation if any was caused by air pollution.

R. A recent study by Systems Applications, Inc. (1978) found a decrease in annual average visibility in Billings of about 20 percent over the past 20 years. This was equally true on wet days and days with low wind speed as well as dry days and days with high wind speed. Thus wind blown dust cannot be presumed to be the principal source of the change. The greatest change has occurred for days when the winds are out of the west to north quadrant. Visibility improved throughout the West during the industry-wide copper strike of July 1967 to March 1968.

C. The visibility standard is equivalent to a suspended particulate standard of 6 ug/m^3 annual average. Since the background levels of suspended particulate are 15 to 20 ug/m^3 in Montana, this standard cannot be attained.

R. A standard of $3 \times 10^{-5} m^{-1}$ for particle scattering is roughly equivalent to a concentration of fine particles of 9.6 ug/m^3 (Waggoner and Weiss, 1980) annual average. This does not imply that the total suspended particulate measurements will be anything like 9.6 ug/m^3. They may be as high as 150 ug/m^3 with only 9.6 ug/m^3 of fine particulate. It is only necessary for less than 13 percent of the mass of the total particulate to be less than two micrometers for both the visibility standard and the proposed total suspended particulate standard to be simultaneously satisfied. Typically between 7 and 50 percent of the mass of particulate will be in the fine fraction. The lower percentage is more likely to be found in the dry areas of the high plains while the latter is more likely in polluted urban cities like Los Angeles. If the background particulate concentrations in Montana are 20 ug/m^3, the fine particulate fraction is quite likely less than 5 ug/m^3 annual average.

C. The influence of visibility impairment on visitor enjoyment of Glacier National Park can best be measured with a multi-contrast telephotometer. The integrating nephelometer is applicable only to a single point.

R. The multicontrast telephotometer does measure visibility over a long range, but the measurement of contract that it makes under many weather conditions are not well related to the clarity of the air. Especially when the sky is overcast its measurements of contrast will not reflect perceptions of air quality. If the integrating nephelometer is properly sited the values recorded can be representative of the observed visibility.

C. The integrating nephelometer has serious limitations as a measurement of visibility. It measures only the light scattering of particles, not their absorption. It measures only the air pollution at a single place, not

over an entire sight path. If one tries to calculate a visibility distance from it, one must assure that the air is uniformly dirty over the sight path, that the earth is flat, and that the target is black.

R. Because it is difficult to convert the readings from any instrument available into visibility (the multi-contrast telephotometer has similar problems) the standard is established in terms of a particle scattering coefficient instead of a visual range. Of the problems stated, the first two tend to understate the visual range based on nephelometer data while the last tends to overstate it. It is not clear which effect is dominant under most conditions. The nephelometer does measure pollution only at a single place, but then so does any other air pollution monitoring instrument. Finally, it does not monitor the absorption of particles, but this is typically a small part of the total scattering coefficient under Montana conditions. Failure to include absorption the visual range estimated from nephelometer readings would result in overestimation of the range.

C. After making several assumptions we calculated the anticipated effects of the proposed Montana air quality standards on visibility. We show that large-scale reductions in ambient sulfur dioxide would be required to meet the proposed regulations.

R. We have carefully reviewed your calculations. Many of the assumptions are without merit. Some of your conclusions illustrate the magnitude of the error in your estimates. For example, you calculate that the annual average visibility at Billings is 16 miles, while it has been measured at more than 60 miles.

C. The emissions from the Stauffer plant probably would exceed the visibility standard.

R. The visibility standard is not a measurement of plume density, but rather a measurement of ambient air quality. Also, the proposed standard would apply only to Class I areas. The Stauffer plant is not located in a Class I area. The nearest Class I area would be the Anaconda Pintlar Wilderness area which is approximately twenty miles to the west.

C. The growing season fluoride standard would not protect vegetation and animals. The standard should be no higher than 0.05 ppb.

R. The 0.13 ppb growing season average proposed in the draft EIS has been dropped from consideration. It was dropped because analysis of fluoride data from fluoride sources in the state indicated that a growing season standard was redundant with the other proposed standards in protecting the environment. Furthermore, reanalysis of the scientific data upon which the growing season standard was based cast doubt as to what fluoride concentrations actually were present and whether damage resulted from a series of short-term high level concentrations or, as previously thought, from a five-month average below the short-term threshold.

C. A 0.22 ppb 30-day average gaseous fluoride concentration would allow 30 ug/g fluoride in forage. The standard of 0.30 ppb would not protect foraging animals. It should be 0.20 ppb to ensure consistency with the forage standard.

R. Tolerable fluoride concentrations were determined from studies citing ambient concentrations capable of causing excessive fluoride levels in vegetation and causing visible injury to Montana plants. After analyzing all studies, the 0.30 ppb standard was proposed. It was judged from the study results to be a protective standard.

C. The draft EIS overlooked many significant scientific studies in determining the proposed fluoride standards.

R. All pertinent scientific studies conducted in Montana on the effects of fluorides were reviewed. These studies are most appropriate for determining Montana fluoride standards. Furthermore, every attempt was made to evaluate all applicable studies performed outside Montana on the effects of fluoride in the environment.

C. The synergistic effects of various air pollutants occurring together in the ambient air were not considered in establishing the standard for fluoride.

R. The major sources of ambient fluoride in Montana are located in areas where contributions of other pollutants are minimal. As a result fluoride is not found in combination with other pollutants in magnitudes sufficient to cause a synergism problem. It therefore was not considered in establishing a fluoride standard.

C. It is possible that industrial sources could pollute below the proposed 30-day fluoride standard of 0.30 ppb and still cause fluoride accumulation in vegetation greater than 30 ug/g, and a seasonal level above the proposed 0.13 ppb growing season average. The 30-day standard should be tightened to ensure consistency between the standards.

R. The proposed growing season standard has been dropped for reasons stated in a previous comment. Based upon these considerations a 30-day standard of 0.30 ppb should provide protection for Montana vegetation from all presently known long-term effects.

The statement that the proposed 30-day average will allow 30 ug/g fluoride in vegetation is based on several uncertainties. As can be seen from Table III.G-1 on page 197 of the draft EIS, the accumulation rate of fluoride in vegetation varies depending on the environment of the plant, stage of development, and weather conditions. When all study results listed in Table III.G-1 are considered together, it appears the ambient fluoride concentration necessary to generate a 30 ug/g accumulation in plants is within the proposed standard.

C. There is no provision in the proposed standards to assess fluoride impact on vegetation which is not grazed or browsed.

R. The forage fluoride standard is designed to protect herbivorous animals. The gaseous fluoride air quality standards are for the protection of vegetation.

C. Elevated fluoride levels found in wildlife and game animals near Colstrip power plants were not discussed in the draft EIS.

R. Several studies conducted near Colstrip found fluoride accumulation in rodent populations. No adverse effects were reported.

C. A study entitled "Recommended Practices to Reduce Fluorosis in Livestock and Poultry" (Utah State Agricultural College, 1952) recommends a fluoride forage standard of 25 ppm. The report notes symptoms of fluorosis appear in cattle when forage contains 20 ppm fluoride. This study along with the results of Miles et al. (1978) and Krook and Maylin (1979) cited in the draft EIS argue for a forage standard of 20 ppm to minimize the impacts on livestock.

R. The Utah Agricultural College Study cited above has been reviewed. It does not provide any scientific data to support its recommendations, only indicating that experiments show that animals seem to suffer more from fluoride ingestion when in pasture than when fed dry forage.

The Department took this into consideration when formulating the proposed forage standard. The Department based the forage standard upon a fluoride level low enough to protect livestock and other animals from any reduction in their intended use. An annual level of 35 ug/g in forage with no monthly value exceeding 50 ug/g was judged sufficient. These numbers were based on results from a number of controlled experiments and considerations of increased sensitivity in non controlled environments, such as a pasture.

C. There are contradictory statements in the draft EIS concenring the usefulness of bone fluoride as an indicator of fluoride damage to livestock.

R. The statement on p. 269 that bone fluoride levels are not the best indicator of fluoride damage to livestock is not complete. The discussion of bone fluoride in the draft EIS was intended to suggest that bone fluoride is not always a reliable indicator of fluoride-induced damage in cattle. The draft EIS refers to evidence that bone fluoride is a reliable indicator in adult cattle but not in calves.

C. The Applegate and Adams (1960) study cited on p. 198 of the draft EIS is said to support the proposition that fluoride causes a reduction in photosynthesis. Other studies (Treshow and Harner, 1968) and MacLean et al. (1967) tend to contradict the results of Applegate and Adams.

R. The reference to the Applegate and Adams (1960) study should read ". . . an increase in respiration" on p. 198 rather than ". . . a reduction in photosynthesis." The two scientific studies (Treshow and Harner, 1967 and MacLean et al 1967) deal with growth stimulation at certain plant fluoride levels rather than increased respiration. They analyze other scientific parameters than the Applegate and Adams paper and therefore are not contradictory. The discussion of growth stimulation from plant fluoride (p. 194) cites Weinstein (1977) that fluoride stimulation "usually results in a spindly or twiggy growth not beneficial to plants. . ."

C. The summary said that "hydrogen fluoride . . . causes substantial economic damage to plants and animals . . ." and that the standards have been "based on the level of hydrogen fluoride known to cause (substantial) damage." This is not the case.

R. Hydrogen fluoride pollution has caused substantial economic damage in the past in Montana. The sentences referred to carelessly suggest that the standard has been set at a level that would permit such substantial damage. On the contrary, air quality standards to protect vegetation and animals must be set at a level that would minimize the loss to the public.

C. An economic analysis for fluoride standards was included in the Otis, et al. paper. However, this draft analysis did not even cover the proposed ambient standards, but discussed control programs and present ambient requirements for Anaconda Aluminum and Stauffer Chemical. As such it is not an economic cost benefit analysis required by Department regulations under the Montana Environmental Policy Act. Additionally, the fluoride analysis covers only two of the potential sources of fluoride.

R. The paper by Otis, et al. is an independent study supported by a research contract between the Department and faculty at the University of Montana. As such it is not subject to Department regulations. While the study does constitute the major component of the Department's economic projections, it is not the sole basis of the Department's analyses.

The analysis of fluoride pollution and control in the draft EIS included all the available information concerning these two major sources of fluoride in the state. Major control programs being completed at both facilities are the prime consideration in assessing the impact of the proposed standards.

Little information exists as to other fluoride sources in the state and there is no basis for estimating economic or environmental impacts in these areas.

C. In Table III-G1 page 197, the numbers given for accumulation of fluoride at certain atmospheric concentrations:

1. do not consider baseline levels of fluoride in vegetation;
2. are below the proposed 30-day and 150 day proposed standards;
3. do not emphasize the stress effects of field experiments as contrasted to laboratory experiments.

R. The 0.30 ppb hydrogen fluoride standard derived in part from Table III G-1 comes from a sensitivity comparison of all plant species tested, including consideration of response variability, and with added emphasis to the field studies of Israel (1974) and background fluoride levels of 0-3.6 ug/g found in uncontaminated vegetation. Justification for the standard also comes from other studies not cited in Table III G-1 that show damage to plants from monthly fluorine levels. In this light, particulate fluoride was not considered in setting a 30-day standard because of its low toxicity to vegetation.

C. Studies cited in the draft EIS relating vegetation damage from atmospheric fluorides utilized calcium formate plates to measure hyrogen fluoride concentrations. This technique is inaccurate and unreliable. The data thus obtained are ambiguous at best and should not be relied upon in setting the fluoride standards.

R. In general it is true that the calcium formate method is more uncertain in determining hydrogen fluoride levels than are automated methods of

measurement. However, the relative reliability of the methods varies according to environmental conditions. During the studies which utilized calcium formate plates to record hydrogen fluoride concentrations, the conditions were judged either by the authors of the studies or by the Air Quality Bureau to be conducive to an accurate estimation of the average concentrations of fluoride cited in the studies. These average values were used in the conclusions drawn in the draft EIS.

C. The Department attributes all the alleged damage to vegetation and wildlife near Columbia Falls to fluorides from the Anaconda plant and ignores other unrelated, obvious, and proven cases.

R. Only valid scientific studies of fluoride impacts were used in the discussion. The sole source of fluoride pollution near Columbia Falls is the Anaconda plant. The damage from this plant was determined in scientific studies to be different from that caused by management practices, environmental conditions, and other pollution sources in the area.

C. The longer averaging times (24 hour, 30 day, growing season) used in definition of the proposed fluoride standard makes enforceability difficult. As a result, the monitoring network required to gain useful evidence for enforcement requires a great deal of effort to produce a marginally acceptable case. Emission tests of specific sources are simple, direct and nearly irrefutable.

R. The sources of substantial fluoride emissions in the state are isolated enough from sources of interfering contaminants to allow adequate enforcement of the proposed standards. The proposed standards will be used in conjunction with emission testing to ensure compliance.

C. Suttie (1969) advocates a yearly foliar fluoride level of 40 ppm, not to exceed 60 ppm more than two months, or 80 ppm for more than one month. A weighted average such as this would more accurately reflect the injury potential faced by foraging livestock. This approach to setting standards has been taken by several states.

R. The standards advocated by Suttie (1969) are based on extrapolation of data from controlled feeding experiments. They have not been tested to determine if they protect domestic animals.

The Department reviewed the work of Suttie and others and generally agrees that: 1) an average forage standard rather than a spot sample is necessary to protect domestic animals; 2) a short-term monthly standard is necessary to prevent symptoms of fluoride toxicity to animal teeth. The Department believes that an average value somewhat below Suttie's recommendations are necessary to protect animals under field conditions. It is felt that conditions of nutritional and environmental stress, prenatal exposure, and fluctuating fluoride consumption argue for a lower standard than controlled feeding experiments where shelter and optimum nutrition are provided.

C. The 24-hour fluoride standard appears arbitrary and more restrictive than necessary for protection of the environment.

R. The proposed standard is based on the level of fluoride above which sensitive Montana conifers are damaged. An economic analysis (Otis et al. 1978) indicates that benefits to the environment of adopting such a standard at least equal the cost of control.

C. The 30-day and growing season fluoride standards are too stringent and are unjustified in terms of real reductions in plant damage.

R. The growing season standard has been dropped from consideration for reasons discussed in a previous comment. The 30-day standard is intended to reduce excessive fluoride accumulation and foliar damage from longer term low concentration effects of fluoride. A report by Otis et al. (1978) indicates that protection of vegetation will provide a net social benefit to residents of the state.

C. There is no basis for assuming a forage standard derived from observations of damage to cattle would protect wildlife which consumes different types of vegetation.

R. Toxicity does not depend on the type of vegetation consumed, only on the amount of fluoride consumed. A standard to protect the most sensitive domestic species (cattle) was judged to also protect wildlife. This assumption has not been tested. Until further testing defines the level of toxicity in sensitive wildlife species the present level of knowledge was deemed sufficient to define the proposed standard.

C. Evidence (Miles et al. 1978; Krook and Maylin, 1978) cited as a basis for a fluoride forage standard associates livestock damage with forage fluoride levels no higher than 32 ppm. Actually these studies report fluoride levels much lower, ranging from 10 to 18 ppm. If one assumes that a level less than the maximum accumulated value causes damage, then the proposed fluoride forage value is probably too loose to ensure protection of livestock.

R. The values mentioned above (10-18 ppm) were reported in Miles et al. (1978) study. A reanalysis of the sampling protocol used in this study indicates that the conclusion that cattle are injured at levels below 35 ppm is unwarranted. Sampling was conducted on only one occasion during the study, and no attempt was made to associate grazing use with the content of fluorides in these samples. Because single samples are quite variable in fluoride content and because long term ingestion of specific levels of fluoride are necessary to cause toxicity, the results of the Miles et al. study were viewed as suggesting that cattle are injured at lower fluoride levels than observed from controlled feeding experiments.

The Krook and Maylin (1978) study suffered from similar shortcomings. The value of this research was not in the level suggested to cause fluorosis in the observed cattle but in the hypothesis suggesting a mechanism that makes cattle become fluoritic at levels of foliar fluoride lower than those causing fluorides in controlled experiments.

C. The proposed 30 ug/g fluoride forage standard is reasonable. A number of fluoride sources are known to operate with no fluoride removal equipment without producing concentrations this high.

R. Comment noted.

C. The 1.0 ppb 24-hour fluoride standard would not protect vegetation from damage. It should be 0.05 ppb pending further study.

R. According to the studies reviewed in the draft EIS, 1.0 ppb would protect Montana vegetation. A 0.05 ppb standard also would be protective but is not justified in light of the extensive control equipment that industries would need to meet the standard.

C. The Boyce Thompson Institute found that a 3.5 ppb 24-hour fluoride standard would protect the environment.

R. Evidence presented in Table III G-11 indicates damage to vegetation occurs at much lower levels than asserted by the Boyce Thompson Institute.

C. No other state has found it necessary to adopt 30-day or growing season standards similar to those proposed in the draft EIS.

R. The Canadian federal air quality standards regulate gaseous fluoride as follows:

Period	Max. acceptable (ppb)	Max. desirable (ppb)
24-hour	1.0	0.5
7 days	0.7	0.2
30 days	0.4	--
70 days	0.2	--

The Department felt that a 30-day standard was necessary for protecting sensitive vegetation from long-term chronic fluoride injury and excessive fluoride accumulation.

C. The draft EIS says in its introduction that the proposed fluoride standard is based on a level of hydrogen fluoride "known to cause . . . damage."

Yet throughout the draft reference after reference is no stronger than "suggests," "indicates," and other uncertainties as to whether fluoride causes damage. Nowhere is it said that a given level is known to cause damage.

R. Determining the amount of ambient air fluoride which may be said to "cause damage" under various circumstances depends in part on scientific judgement. Nevertheless, there is more or less universal agreement that various levels of fluoride under various conditions will cause a variety of damage to the natural and economic environment. The draft EIS says this clearly. On page 189, for example, it says,

> *Air and vegetation fluoride levels commonly recorded in Montana have been shown to adversely affect plants and animals. Fluoride has been shown to cause alterations in plant biological processes leading to tissue death and growth losses in many types of plants, particularly timber species.*

COMMENTS ON THE HEALTH EFFECTS OF HYDROGEN SULFIDE

C. Stinking air is not good for people and should be prevented by air quality standards. The threshold of odor should be the standard.

R. Obnoxious smells are not considered hazardous to the public health. Therefore, hydrogen sulfide is regulated by a "welfare" standard, which must be based on practicability. A standard set to bring hydrogen sulfide concentrations below the odor threshold would alleviate public complaints, but it might not be practicable because of high control costs required to achieve such levels.

C. In addition to the effects noted in the draft EIS, hydrogen sulfide levels in Missoula have a definite psychological effect on valley residents.

R. First, it is not entirely clear that hydrogen sulfide is, in fact, all that residents of Missoula are smelling. Other emissions are more potent odorants and could be the cause of the odor problem. Second, there is no study of psychological effects in Missoula upon which to base a standard.

C. The EIS asserts that computer modeling and emission information indicates that the current level of emission would not violate a standard set to protect health. Why was there no hydrogen sulfide emission or computer modeling data in the EIS to evaluate the statement?

R. The last sentence on page 231 should read as follow: Ambient monitoring indicates that the current level of emission would not violate a standard set to protect human health.

C. The smell of hydrogen sulfide is perceivable between 0.0015 and 0.0075 ppm. The proposed standard would allow concentrations 65 times higher than this threshold level. The psychological health effect of this nauseous odor on people is clearly as important as physiological health.

R. The concept of psychological health as related to odor is not clearly defined, and the little information available was cited in the EIS.

GENERAL COMMENTS ON HYDROGEN SULFIDE

C. Why was the hydrogen sulfide standard not set to respond to public nuisance when studies cited at page F-5 indicate a public nuisance exists?

R. The study by Huey et al. (1967) was not a scientific study of community nuisance reaction, but an observation by a few professionals of situations they had observed.

It is not currently known what level of hydrogen sulfide functionally constitutes a "public nuisance". The Department examined the relevant scientific information and estimates the concentration of hydrogen sulfide necessary to produce complaints among a significant group within a community. The proposed standard of 0.05 ppm, hourly average, derived from an assessment of practicability, should prevent the majority of complaints.

C. The work of Thompson and Kats (1978) on hydrogen sulfides toxic effects to vegetation should not be used as a basis for the proposed one-hour standard. These researchers found damage at concentrations higher and longer than the level allowed by the proposed standard.

R. The draft EIS said on p. 276 that the justification for the proposed one-hour dydrogen sulfide standard is based on protection of the public health. The work of Thompson and Kats (1978) indicates that hydrogen sulfide at levels in accordance with the standard would damage Douglas fir with long term continuous exposures. No such continued exposures are predicted in Montana.

C. The first sentence of the third paragraph on page 223 states: "Thompson and Kats (1978) also observed that the yields of Hayden and El Dorado alfalfa varieties were not reduced at 0.03 ppm hydrogen sulfide but that 0.3 ppm reduced growth significantly." The data from Table III-H-1 shows that El Dorado alfalfa showed a two percent weight loss at 0.03 ppm and Hayden alfalfa showed a seven percent weight loss at cutting #2 at 0.03 ppm H_2S. Therefore yields were reduced at 0.03 ppm.

R. The sentence meant that no significant reduction of yields was noted at 0.03 ppm. Two and seven percent reductions were not determined to be significant at the one percent level while reductions at 0.3 ppm were significant.

C. The draft EIS said in Table III.H-1 that tip burn occurs to ponderosa pine at 0.03 ppm hydrogen sulfide after 76 days of exposure. At the same time P. 223 states that after 10 weeks 0.03 ppm hydrogen sulfide caused no visible effect. Which is correct?

R. A review of the Thompson and Kats (1978) paper indicates that Table III.H-1 is in error. It should read "no tip burn was found in ponderosa pine after 0.03 ppm hydrogen sulfide exposure for 76 days." Furthermore the work of Carlson (1974) cited on p. 225 should read: "Carlson's study found substantially more injury to Douglas fir than ponderosa pine, in accordance with the findings of Thompson and Kats (1978)."

C. The discussion in the draft EIS of hydrogen sulfides effects to plants, livestock and ecosystems was inadequate.

R. All available information on the toxic effects of hydrogen sulfide was included in the draft EIS. The standard now proposed should protect most plants, livestock and ecosystems in the state from the known or anticipated effects of the pollutant.

C. We strongly oppose reduction of hydrogen sulfide standard from 0.03 ppm 1/2 hour average to 0.1 ppm 1-hour average. The air we breathe and smell should be considered a nondegradable resource to be protected for future generations.

R. Comment noted.

COMMENTS ON THE EFFECTS OF CADMIUM, ARSENIC, SELENIUM AND BERYLLIUM

C. Even though it is not possible to be absolutely certain what the standard should be, it is necessary to set standards for cadmium, arsenic, beryllium and selenium.

R. The Department intends to examine the need and practicability of establishing standards for these pollutants as soon as the proceedings are completed on the nine more pervasive pollutants discussed in this EIS.

C. Arsenic and cadmium are toxic substances with known health effects. They are also known to be emitted from industrial sources in the state. Why was no standard adopted for these air pollutants?

R. There is little ambient air monitoring data to characterize levels of cadmium and arsenic in Montana. The Air Quality Bureau will monitor both cadmium and arsenic in the future and will review the expanding literture to determine safe exposure levels. When this information becomes available, ambient cadmium and arsenic standards may be proposed.

C. Why was the beryllium standard dropped? There are sources of the substance in the state and recognized human health effects from exposure.

R. The estimated emission levels of beryllium in the state are extremely small. Estimated ambient levels are far below those known to produce adverse human health effects.

C. Why is the standard for beryllium being dropped? According to working paper #2, the Colstrip power plants are major sources of beryllium. Furthermore, future coal conversion plants will be major sources. The problem will increase and should be prevented before it causes ill health and environmental damage.

R. A new standard for beryllium is being delayed for further review along with several other pollutants. Standards for these pollutants may be proposed in the future if deemed necessary. The amount of beryllium estimated in working paper #2 to be potentially emitted from the Colstrip plant was based on studies made prior to start up of the facility. Subsequent studies indicate much lower emissions.

C. The DEIS barely mentions the impacts of trace element fallout on insects. Such impacts are discussed at length elsewhere. For example, the Congressional Research service, in a 1975 report to the Subcommittee on the

Environment and the Atmosphere, noted that deaths of pollinating insects caused by arsenic have been reported three miles from power plants. It is also reported that as of 1975, total selenium mobilization from coal combustion alone was 1.5 to 2.5 times the level naturally produced by weathering mobilization, indicating a profound man-made influence on total selenium mobilization.

R. Standards for arsenic and selenium will be investigated after standards have been set for the pollutants currently under review.

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III. POLICY CONSIDERATIONS IN DEVELOPMENT OF AMBIENT AIR QUALITY STANDARDS

INTRODUCTION

The purpose of this chapter is to outline and clarify the policy considerations underlying the development of the Department's proposals.

The chapter is divided into three sections. The first section summarizes the statutory directives contained in the Montana Clean Air Act. The second outlines and discusses the Department's methodology for determining the standards. The third section clarifies how the Department chose among alternative ambient air quality standards.

Montana Clean Air Act

Section 75-202 of the Montana Clean Air Act (MCAA) provides:

> Board to set ambient air quality standards. The board shall establish ambient air quality standards for the state.

Section 75-2-102 of the MCAA provides:

> Policy and Purpose. (1) It is hereby declared to be the public policy of this state and the purpose of this chapter to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state.
>
> (2) It is also declared that local and regional air pollution control programs are to be supported to the extent practicable as essential instruments for the securing and maintenance of appropriate levels of air quality.
>
> (3) To these ends it is the purpose of this chapter to: (a) provide for a coordinated statewide program of air pollution prevention, abatement, and control;
>
> (b) provide for an appropriate distribution of responsibilities among the state and local units of government;

(c) facilitate cooperation across jurisdictional lines in dealing with problems of air pollution not confined within single jurisdictions; and

(d) provide a framework within which all values may be balanced in the public interest.

In preparing its recommendations the Department has necessarily referred to Section 75-2102 which sets out the policy and purpose of the Montana Clean Air Act. That section requires the Board to engage in a two-step process in the establishment of air quality standards in Montana.

The Board must first determine what levels of air quality are necessary to protect human health. The Board must establish air quality standards to achieve at least that level of air quality.

Once the level needed to protect human health is determined, the Board must decide whether other social, environmental, or economic needs of Montana call for air quality beyond that necessary to protect human health. The Board accomplishes this second step by weighing the four specific "welfare" factors set out in section 75-2-102. If the Board's weighing of these factors indicates a need for air quality beyond that required to protect human health, then more stringent ambient air standards may be established to achieve such air quality levels. If the Board concludes that the advantages to be gained by better air quality are outweighed by considerations pertaining to the other objectives, then it may leave the standard at the level required to protect human health. Direct economic comparisons among these factors is not possible. Section 75-2-102 contemplates that, once human health is protected, the Board has broad discretion to balance these objectives and establish standards which will serve the state as a whole.

A standard established to protect human health includes a margin of safety to account for uncertainties and hazards which research may not yet have identified or resolved. The margin of safety for any given pollutant is determined by the acceptability of the risk associated with the pollutant. A

standard established to protect a welfare interest such as wildlife or vegetation is not specifically designed to include such a margin of safety. The level of air quality needed to protect welfare interests is based upon effects which are either known or may reasonably be anticipated.

Policy Considerations

The Montana Clean Air Act requires establishment of ambient air quality standards sufficient to protect human health and welfare. The standards cannot be derived solely by reference to available scientific information. The process of setting such standards demands that some judgments be made and applied to the available information. For example, if health is to be protected, is it only healthy persons who should be protected? Conversely, must every aspect of health be protected from every possible effect of air pollution?

As a foundation for the standards, the Department gathered and analyzed information concerning the sources, concentrations and effects of pollutants. The information was assessed in accordance with the policies which the Department is carrying out. Therefore, the final form of the rule derives from the application of a policy framework to scientific findings.

Several policy choices were made by the Department and incorporated into the proposed rule. They may be stated generally as follows:

Protected population: Health standards are established to protect not only healthy persons but also the most sensitive or vulnerable segments of the population.

Health Related Response - The Department concluded that a response is of regulatory concern if it results in or contributes to a reduction in one's present or future capacity to engage in normal activities. The Department's determinations of whether a response is health-related were made on a case-by-case basis.

Level of Apparent Health Response - For some pollutants there is no apparent health effects threshold below which exposure may automatically be deemed safe. Therefore rather than use the term threshold, the Department has used the term "level of apparent health response" to indicate the pollutant level at which health related responses begin to be observed. This level of apparent health response dictated the minimum standards for each pollutant.

Margin of Safety - There are uncertainties concerning the full range of health effects caused by air pollutants. To account for these uncertainties the Department generally has proposed a standard more stringent than the level of apparent health response. The margin of safety is based upon a case-by-case evalution of the uncertainties and risks associated with a given pollutant.

Enforceability:- The ambient air quality standards are recommended to be legally enforceable limitations which may be enforced by the measures provided in the Montana Clean Air Act.

Ambient Air - The Department has determined that the ambient air standards are to be enforceable in areas to which the general public has access. The standards are not enforceable inside the property lines of pollution sources.

Discussion of these policy considerations is incorporated into the discussion on Determination of Ambient Air Quality Standards.

Determination of Ambient Air Quality Standards: Summary

The process followed by the Department in determining the proposed standards may be summarized as follows:

1. Compilation and Assessment of Scientific and Factual Information. The Department first reviewed the available health effects literature on pollutants of concern in Montana. It focused upon studies indicating effects of concentrations at or near the federal standards. Information was also assembled regarding the various pollution sources within the state.

2. Determination of Which Pollutants to Regulate. The Department selected for regulation those pollutants currently occurring in significant levels in the state and for which there was scientific evidence to derive a meaningful standard.

3. Determining the Level of Apparent Health Response. The Department relied on scientific information to establish for each pollutant a level which apparently was sufficient to produce a detectable health response to whichever segment of the public was most vulnerable.

4. Margin of Safety. Once the level of apparent health response was established, the Department assessed the risk associated with unknown effects of the pollutant. Several factors were weighed to determine what level of risk was acceptable to assure protection of public health. In accordance with that estimate, the standard was made more stringent than the level of apparent health response.

5. Considerations Above and Beyond Health to Determine Final Standard to be Proposed. Once the health standard was determined, the Department reviewed the scientific evidence to determine whether the pollutant would have effects upon the state's economic and social welfare at concentrations lower than the level required to protect health. Where such effects were likely to occur,

they were weighed against the other specific welfare interests specified in section 75-2-102 of the Montana Clean Air Act to determine whether a standard to protect more than human health was "practicable." If the anticipated impacts were not offset or outweighed by the other concerns, then the standard was modified to prevent anticipated welfare effects.

DETERMINATION OF AMBIENT AIR QUALITY STANDARDS: DISCUSSION

Compilation and Assessment of Data

1. Use of Data - The initial task of the Department was to gather scientific information concerning air pollutants of concern in Montana. In order to gain an overview, the Department conducted a computerized scan of literature on the effects of air pollutants on the public health and welfare. Much of this literature was cited and discussed in the EIS.

While it did consult the general body of scientific data, the Department chose to focus its attention upon studies indicating effects at or near the federal standards. The proposing of state standards less stringent than the federal standards would have been a largely academic exercise.

Throughout the process of reviewing scientific data, the Department preferred to consult original scientific papers and generally avoided reliance upon reviews which summarize and critique several different studies in a particular area of research. Reference to original articles allowed the Department to examine the actual experiments conducted and thereby to assess the degree of reliability of the scientific conclusions. There also was a preference for studies appearing in scientific journals since they are more widely available and generally will be better known by other researchers in the field. Some reports by government agencies also receive wide distribution and were utilized where appropriate.

In certain cases, reports published by panels of scientists have drawn conclusions based upon a review of existing literature. Some researchers suggest that these reports embody the scientific consensus regarding any given pollutant. The Department seriously considered the findings of such panels but did not automatically defer to their conclusions.

A scientific consensus depends in part upon common assumptions governing the interpretation of data. Not all researchers approach scientific data with the same assumptions. For example, some researchers may contend that there is a safe effects threshold for every pollutant or that reversible effects have no biological significance. Other reseachers may proceed under different assumptions. Therefore some scientific disagreement and uncertainty is inevitable concerning important factors in the setting of standards.

2. Types of Studies - Three types of experiments are used to define the impacts of air pollutants on human health: animal studies, clinical studies, and epidemiological studies.

Animal studies are valuable for determining the effects of pollutants on laboratory animals under controlled conditions in experiments that would be too hazardous with human subjects. Animal experiments allow the use of high pollutant concentrations and examination of affected tissues. They make possible the repetition of experiments and the determination of relationships between given pollution levels and the effects observed. Although the findings of these studies are not directly applicable to humans, there is a general understanding that responses found in experimental animals may be paralleled in humans.

Clinical health studies are used for more direct determination of air pollution responses in humans. The advantage of this method is that precise levels of pollutant can be administered under consistent study conditions. Because the experiments usually use volunteers, often college students, it is

difficult to experiment with long-term or repeated exposures. There is little doubt these studies understate the effects on the general population, given the better than average health of college students.

The epidemiological studies evaluate health responses under ambient conditions common to the human environment. Testing for low level effects in humans often is possible only through statistical survey in cities alike except for their pollution levels. These studies relate pollution levels to illness and death rates. Epidemiological studies are especially useful in identifying a sensitive group or detecting an unusual type of illness or cause of death that might be associated with pollution.

Each of the three types of studies has its own benefits and disadvantages. A good epidemiological study is probably the most desirable, since it most closely reflects the everyday world. However, it is extremely difficult to produce clear results, because of the large number of uncontrolled variables inherent in any such study. One approach is to rely on epidemiological results only if they report effects consistent with clinical and animal studies.

Some researchers use only clinical studies. Such studies are the most easily controlled, but are, necessarily, the most artificial, and application of the results to the everyday world often involves data interpretations and inferences that may be subject to dispute.

Animal studies often explore the physiological mechanisms by which pollutant exposures produce effects, but may reveal little about the exposure levels at which human health is affected.

Rather than weighing any one type of study, the Department chose to look for composite sets of results: epidemiologic studies backed up by clinical and animal studies. The greater the degree of consistency and convergence among these three approaches, the more reliable the conclusions.

Protected Population

The objective in establishing health-based ambient air quality standards is to estimate the concentrations of various pollutants in the air to which all groups within the general population can be exposed without an unacceptable risk to health. Susceptibility to ambient air pollution often varies significantly from one person to another. Similarly, different segments of the population with preexisting limitations or health conditions may exhibit more dramatic responses to air pollution than other healthy groups. The question arises as to which of such groups should be afforded protection from health effects.

Congress has specified that the responsibility of the federal government under the Federal Clean Air Act is to protect the most sensitive segment of the population which is regularly exposed to ambient air. The only limitation is that such segments be large enough to be statistically definable.

The Department has determined that it has an equal responsibility to protect the health of Montana's citizens. Therefore standards are designed to protect those persons who are most sensitive or vulnerable to air pollutants. For example, persons with asthma or other respiratory disorders, children, pregnant women and other statistically significant groups, will be afforded protection under the proposed standards. The exact identity of the sensitive populations will vary by pollutant.

Determination of Which Pollutants to Regulate

Once the scientific literature was compiled and reviewed, the initial decision which had to be made was whether a standard should be proposed for a particular pollutant.

There are numerous air pollutants presently found within the state. The Department's review gave particular consideration to the pollutants regulated

in the existing ambient standards rule. Standards for four pollutants (beryllium, suspended sulfate, sulfuric acid mist, and total reactive sulfur) were removed and do not appear in the rule proposed by the Department. While standards for these pollutants may again be considered in the future, they are not included in the present proposal for the reasons stated in Appendix F of the draft EIS and on p. 102, Chapter III of this final EIS.

The process of selecting pollutants for regulation is not accomplished by applying a general rule to all pollutants. Certain criteria must be applied on a case-by-case basis. The first consideration is whether the pollutant occurs in sufficient concentrations to warrant the adoption of an ambient air quality standard. In the case of beryllium, for example, there currently are no significant sources in the state nor are any proposed.

Another consideration is the extent of knowledge regarding the effects of a pollutant. The Department proposed a standard only for those pollutants for which there was sufficiency of reliable scientific information. There must be enough reliable scientific information to suggest what concentrations may cause identified effects and what levels are safe. For example, current scientific information on suspended sulfate, sulfuric acid mist, cadmium, polyclic organic matter and arsenic does not provide an adequate basis for specific standards. Intensifying research may allow the adoption of standards for these pollutants in the near future.

Furthermore, the scientific information must be sufficiently precise to allow accurate measurement of pollutant concentrations and enforcement of standards. It is only with such information that a standard may be confidently derived.

A standard for sulfuric acid mist would be impractical because of the difficulty of operating ambient measuring devices accurately under field condition. A standard for total reactive sulfur was not proposed because of

ambiguities associated with the sulfation plate measurement method. Scientific research has associated suspended sulfate with health effects but does not yet allow the formulation of an accurate and workable regulation. The Department also reviewed the current evidence on respirable particulates but deferred proposing a standard until more information is available.

Health Related Response

Although the Montana Clean Air Act requires that ambient air quality standards be established to protect human health from the effects of air pollution, not all effects of air pollution necessarily endanger human health. Therefore, in preparing to propose air quality standards, the Department examined the range of pollutant effects and emphasized those believed to be significant to human health.

There is no universal agreement about what constitutes a health related response. Exposure of the human organism to varying concentrations of air pollutants results in a spectrum of responses which may be summarized as follows:

- Substantial and significant effects, such as death or incapacitating disease;
- Clinically observable illness or disability, such as an elevated temperature, a persistent cough, or nausea;
- Subclinical effects or predisposition such as a change in the mucal clearance rate, change in lung function (e.g. mid maximal expiration flow rate), or a change in blood protein composition;
- Body burden and subjective responses, such as an accumulation of heavy metals in the body or psychological responses.

A reasoned judgement was necessary in determining the initial point where health related effects begin to occur on the continuum of physiological response. Also required was a decision concerning the kinds of responses to pollution which could be discounted in establishing the level of apparent health response.

Some physiological responses to air pollution are undramatic but may be biologically significant. For example, chronic exposure to low levels of pollution may go undetected but may have significant effects on health over the long term. On the other hand, effects such as eye irritation may at times be dramatic but are temporary and reversible and therefore may have only minimal biological significance if they occur infrequently.

There are differences of opinion concerning which effects should be discounted in establishing air quality standards to protect human health. It may be stated generally that the higher the levels of pollution, the more medical researchers will agree that a response may be expected and the more medical researchers will agree that the response has biological significance.

One school of thought as to which effects are "adverse" is reflected in the standard used by the World Health Organization. That organization's concept of a health effect includes the "well-being" of the exposed human population. This is a broad perspective which includes subjective considerations such as whether a person feels better or worse on a given day.

Other researchers follow a narrower course. For example, some argue that any effects which were reversible should be discounted in establishing a health standard. According to this view, for example, a chest cold is a temporary and fully reversible respiratory infection and therefore should not be of regulatory concern.

Between these two positions is an approach which adequately protects public health and also allows the Department to discount effects too subtle

to be considered "adverse." The principal factor in determining if an effect is health related is whether it contributes to a reduction in the ability to engage in normal activities. Use of this approach is intended to prevent all but minimal interference with bodily functions upon which physical activity and mental ability depend. For example, a chest cold constitutes a significant interference with the normal condition of the body. A reduction in mucal clearance rate is likely to increase the susceptability of a person to chest colds. Therefore, a measured reduction in mucal clearance rate should be considered an adverse health effect.

Similarly, a subtle change in the formation of blood proteins may not have any immediately observable effect on behavior. However, if prolonged, such interference could leave the body in an anemic state which could significantly reduce the ability to engage in normal activities. Conversely, an effect of minimal biological significance such as eye irritation occurring at sufficient intensity over a short period may create such discomfort that it interferes with normal activities.

The Department has determined that reactions to odor and other subjective responses should be considered nuisance effects rather than health effects.

Level of Apparent Health Response

In the past, health based standards rested primarily on the belief that there were safe pollutant thresholds below which no adverse health effects would be expected even after a lifetime of exposure. Control of emissions to achieve this safe threshold was considered adequate to protect public health.

More recently, increasingly sophisticated scientific research has found definite health responses for many pollutants at concentrations which previously were thought to be below the threshold. This recognition of effects at lower levels suggests that even the lowest levels of these pollutants may affect the human body.

In light of this, the Department has not attempted to establish definite thresholds as the basis for its health-related standards. Rather, the Department reviewed the scientific evidence to establish the range of concentrations at which definite health responses have been observed. The Department has used the term "level of apparent health response" to indicate this range.

Margin of Safety

The Need for a Margin of Safety

The level of apparent health response indicates the pollution concentration at which health related responses have been reliably detected. Setting an ambient air quality standard at that level would limit the public exposure to those effects. However, it does not follow that the public health would be adequately protected at that level.

There are a number of uncertainties associated with the protection afforded at the level of apparent health response. It is because of these uncertainties that the level of apparent health response may not be relied on to determine the standard ultimately needed to protect health. A margin of safety is required to take into account these uncertainties which may be summarized as follows:

Inherent Uncertainty in Scientific Data - Some degree of uncertainty is inevitable in probing new areas of scientific research. The true significance of scientific results may not be known until further research dispels, affirms, or clarifies initial findings.

Undetected Effects - Failure to detect effects at low concentrations is not proof that such effects do not exist. Expanded health effects research along with new investigative methods have and may further disclose adverse health effects at levels lower than those currently believed to produce such effects.

Variable Susceptibility - Susceptibility to air pollution varies from one person to another. Certain segments of the population are sensitive to one or more particular air pollutants. There is no certainty that experiments to date have accounted for the full range of susceptibility to each pollutant. Since much of the experimentation is performed on healthy, young males, the vulnerability of less healthy segments of the population is often unknown. Further research may reveal sensitivities which are as yet unsuspected.

Synergistic Effects - Some pollutants appear to exhibit enhanced effects in the presence of other pollutants. In such cases, the total effect may be greater than the sum of the effects of the individual pollutants. Substantial uncertainty still exists regarding this phenomenon, even for pollutants currently believed to be associated with it. Nor has synergism been demonstrated for every pollutant.

Scientific research regarding pollutant interactions is intensifying. Until such effects are well understood, allowances must be made for the uncertain role they play in environmental health.

Uncertainty in Predicting Actual Exposure - The extent to which the human population will actually be exposed to air pollutants may only be estimated. An individual's exposure to air pollution will depend partly on where he lives and on the amount of time he spends indoors where pollutant levels are typically somewhat lower. For example, some people tend to remain indoors during winter when outdoor air pollution levels generally

increase. Indoor pollutant levels themselves may vary substantially depending, for example, on exposure to gas heating or cooking stoves. Other persons may frequently exercise outdoors in urban areas, thus increasing their exposure.

Meteorological variations occurring on an hourly or daily basis may allow periodic excursions beyond pollutant levels known to produce adverse health effects. These excursions may occur even though longer averaging time ambient standards set at known health effect levels are not exceeded.

Similarly, air pollution monitors cannot be said to measure precisely the actual human exposure to air pollutants. Although monitor locations are selected to reflect typical ambient concentrations, actual pollutant levels at a given place may vary significantly due to variances in air movement, source emissions, and other influences. Therefore, it is inevitable that a monitor at times will either overstate or understate actual human exposure in the vicinity.

The essential objective of ambient air quality standards is to minimize the exposure of the public to harmful air quality conditions. Since many factors combine to determine the level of actual exposure, it may be either more or less intense than anticipated. By making some allowance for the uncertainty in predicting actual exposure, the potential for abnormally high exposures is taken into account.

In light of these qualifications, the level of apparent health response should not serve as the sole determinant of an ambient air quality standard. The uncertainties associated with both the health effects of a pollutant and the

exposures to it must be assessed, and allowances made for them in the final standard. In this way the final standard includes a margin of safety to insure protection of human health.

The Derivation of a Margin of Safety

The specific margin of safety recommended for each pollutant is based upon a reasoned judgement regarding the acceptable level of risk for that pollutant. It is not derived by applying any general rule to all pllutants. Rather, certain common considerations are weighed to assess the degree of protection needed.

The following are indicators of the margin of safety required for each pollutant:

<u>Seriousness of Potential Harm</u> - If existing scientific evidence has associated the pollutant with severe effects such as incapacity or irreversible reduction in lung function, then a wide margin of safety may be necessary. If, on the other hand, only less serious effects have been observed, then less protection is needed and a narrow margin of safety may be acceptable.

<u>Degree of Uncertainty in the Data</u> - In general, the greater the uncertainty the wider a margin of safety is needed. If there is a substantial body of relable scientific information which has largely foreclosed the possibility of effects at lower levels than the level of apparent health response, then a narrow margin of safety may be acceptable. If evidence is inconclusive or if studies suggest effects at lower levels, then a wide margin of safety may be indicated.

<u>Degree of Exposure Across the Population</u> - When experiments indicate the adverse effects of a given pollutant exposure

are seen only in vulnerable segments of the population, such as persons with emphysema, it is likely that healthier people are not subject to the same immediate risks. Although such experiments say little about the long-term ability of healthy persons to tolerate given pollutant concentrations, such results may alleviate the need for a substantial margin of safety. On the other hand, if the harmful effects of the pollutant are observed in healthy young persons, then a substantial margin of safety may be necessary to protect less healthy people.

Likelihood of Occurrence - If there are significant emissions of a pollutant within the state, there is a likelihood that frequent low level concentrations will occur. Frequent exposures of the population to low level concentrations increases the risk that potentially harmful effects will be experienced. In such cases, a wide margin of safety may be indicated. If a pollutant is not present in significant amounts within the state, then public exposure will be less frequent and a smaller margin of safety may be acceptable.

Similar considerations apply to conditions caused by pollutant combinations or synergisms. Occasionally, harmful effects may be anticipated when mixtures of two or more pollutants are present in sufficient concentrations. If the conditions giving rise to the risk are not likely to occur, then a narrow margin of safety may be acceptable. If these conditions are likely to be frequent, then a wide margin of safety may be required.

All the indicators mentioned above must be considered together in the assessment of the risk associated with a pollutant. In the case of a given pollutant, for example, one or two factors may suggest the need for a wide margin of safety while in other cases all factors may indicate a wide margin. These factors are the primary indicators of the appropriate margin of safety. They form the basis for the Department's judgment regarding the levels of acceptable risk for each pollutant.

Considerations of Welfare and Practicability upon the Department's Proposal

Once the level of apparent health response has been determined and the appropriate margin of safety applied to it, there remains the final step in selecting the standard to be recommended. A determination must be made as to whether the social and economic needs of the state require air quality better than that needed to protect human health.

As noted previously, the Montana Clean Air Act requires the Board to establish standards which will not only protect human health but also will, to the greatest degree practicable, foster four goals which embody the social and economic welfare of the state. These welfare goals were previously set out in the discussion on the Montana Clean Air Act (p. 145). They refer generally to the quality of life available to the citizens of the state, including the beneficial use of the state's resources and the availability of employment. They also include the preservation of the state's natural attractions and productivity.

A balance must be struck among the four objectives. Such a balance may be determined only after careful consideration of the needs of the state. For example, use of an area by a polluting activity may foster economic growth and employment but may render the area undesirable for other uses such as agriculture,

residential growth, or recreation. Although section 75-2-102 does not specifically require that each factor must be given equal weight, it clearly obliges the Board to consider the advancement of each objective before adopting a standard.

The Department's recommendations are intended to advance all of these objectives. No single consideration has been accorded paramount importance. It was necessary for the Department to first determine the level of air quality necessary to protect human health. Then the Department examined the scientific research to see whether welfare interests such as vegetation, property, social growth or natural attractions would be affected at lower pollutant concentrations. If such effects were noted, then an attempt was made to determine the advantages to the state of achieving air quality sufficient to eliminate them. These advantages were then weighed against the disadvantages which achievement of such air quality would impose upon attainment of the other objectives set out in Section 75-2-102. If the estimated advantages of better air quality were outweighed by the likely interference with other objectives, then the standard was not made more stringent than necessary to protect human health.

The determination of practicability under Section 75-2-102, is of necessity, largely a qualitative balancing of welfare objectives. It is difficult at best to quantify such things as social comfort and convenience, enjoyment of natural attractions, and socioeconomic development. Certain components of these broad categories, such as crop and timber losses or industrial control costs do, however, lend themselves to varying degrees of estimation. Where available, such information was used by the Department to assess the advisability of proposing standards more stringent than those necessary to protect health.

The Department used all reasonably available and reliable information in striking a balance among welfare objectives. In some cases, scientific evidence suggests that air quality better than that needed to protect human health would protect the state's various ecosystems from the potential effects of air pollution. While this is undoubtedly true in a general sense, there is not sufficient reliable scientific evidence to allow assessment of these advantages with any degree of accuracy.

For similar reasons, long-term projections concerning matters such as the rate of energy development in the state or the future economic consequences of air quality regulation upon industry and employment were avoided since such projections involve substantial speculation.

For six pollutants (sulfur dioxide, particulate matter, carbon monoxide, nitrogen dioxide, photochemical oxidants, and lead) the standards now proposed by the Department were indicated by human health considerations. Given the limitations of current scientific knowledge on the environmental effects of air pollution, there is very little basis for determining the respective advantages and disadvantages of standards below those necessary to protect human health. However a review of scientific evidence indicates that in every case the standards proposed to protect human health with a margin of safety will also to a great extent prevent known or anticipated effects upon the state's welfare interests. Therefore, none of the standards for these six pollutants was made more stringent on the basis of welfare considerations.

As to the four remaining pollutants (hydrogen sulfide, settled particulate, fluorides and visibility impairment) the standards now proposed by the Department were indicated by welfare considerations rather than health considerations. In the case of hydrogen sulfide, fluorides and settled particulate, effects on human health are observed only at concentrations above those levels asso-

ciated with welfare effects. Visibility impairment is not directly related to human health. Therefore, standards for these four pollutants were determined by the balancing of welfare objectives.

While the Department used economic information, it did not engage in discrete cost-benefit analyses for standards based upon considerations of practicability. Precise cost and benefit information is difficult to obtain. Moreover, the Montana Clean Air Act does not require that a welfare-based ambient air quality standard be justified by a dollar for dollar cost-benefit analysis. In its recommendations the Department sought to advance the best interests of the state as a whole, as expressed in the four objectives established by the Legislature.

ALTERNATIVE AMBIENT AIR QUALITY STANDARDS

As noted earlier, the ambient standards rule proposed by the Department is based upon the application of a policy framework to scientific and technical information. This policy framework is derived from the Montana Clean Air Act. Pertinent aspects of this process have been reviewed and discussed in the draft EIS and elsewhere in this final EIS.

The scientific and technical information gathered and assessed by the Department serves as the foundation for the proposed ambient standards rule. In general, such information is made up of scientific findings, which by themselves do not constitute an ambient standards rule. Policy considerations must be applied to these findings in forging a rule which will carry out the mandates of the Montana Clean Air Act. Policy decisions generally do have alternatives.

The fact that the proposed rule has resulted from the application of policy to a process of information review makes it difficult to discuss alternatives which would apply to a site-specific project such as a bridge or highway.

Alternatives in ambient air standards rulemaking fall among a wide range of policy choices.

The Department has previously identified and discussed a number of individual policy areas inherent in establishing the proposed rule. Each of these policy areas itself has alternatives. For example, the Montana Clean Air Act requires that standards be established which will protect human health. A decision must be made regarding which responses of the human body to air pollution signify some threat to health. Judgements as to what constitutes a health response could range from "only severe and irreversible effects" to "any detectable biological effect." The determination of what is a tolerable pollutant concentration thus has a major role in the setting of an air quality standard. Similarly, a decision as to whether reactions to odor or other subjective responses should be considered a health response could importantly affect what levels of pollutants would be acceptable.

An analysis of the proposed rule reveals that these selections, among alternatives within each of these policy areas, led to the final determination of standards. Different standards flow from different choices among policy components. Elsewhere in the final EIS the Department has clarified the reasoning behind its choices in these basic policy areas. A consideration of the alternatives to the Department's choices is implicit in such discussions.

In a theoretical sense, there are no alternatives to the Department's proposed standards. The Montana Clean Air Act requires the establishment of standards which will protect health and welfare. The Act calls upon the Board to decide what concentrations of pollutants are acceptable within the state. Once the policy decisions are made, the process of reviewing information leads to a decision as to what standard is appropriate. This principle is perhaps best illustrated in the assessment of risks which leads to a margin of safety included in a standard. After all considerations are weighed, the

Department can make only one judgement as to what level of risk is tolerable and only one judgement as to what margin of safety is appropriate. Such judgements implicitly consider and reject all other alternatives.

In this sense, the Department could recommend the no-action alternative (i.e., recommend the standards in the existing ambient rule) only if the application of its policy decisions to scientific and technical information indicated that the standards in the current ambient rule would carry out the mandate of the Montana Clean Air Act better than any other standards. For example, the current rule includes a standard for suspended sulfates. Even though sulfates have been suspected of causing health and welfare effects, the Department decided to establish standards only where there is sufficient reliable scientific information to allow formulation of a standard. Such information regarding sulfates is not yet available. Therefore no standards for sulfates have been proposed at this time and, at least for this pollutant, the no-action alternative has implicitly been rejected.

Similar reasoning applies to the alternative of recommending adoption of the national ambient air quality standards. In some cases, the Department recommended adoption of standards identical to existing national standards. In other cases, the Department's evaluation indicated the advisability of standards somewhat more stringent than national standards. In a few instances the Department proposed standards for pollutants which have no national standards.

Recommending adoption of the national ambient standards in their entirety without an independent evaluation by the Department would not fulfill the responsibility imposed upon the Department by the Montana Clean Air Act. This is especially true since there is an important element of judgement inherent in establishing standards which will protect human health.

In actuality, the individual national ambient standards were considered as alternatives in the Department's evaluation of possible standards. As noted above, specific national standards were in some cases selected as the proper alternative. In such cases, however, the recommended state standard coincided with the federal standard purely because the state policy as applied to the relevant scientific information independently indicated the same number set forth in the federal standard. There was no effort to justify the federal standard as such.

IV. ENFORCEMENT

SUMMARY OF DEPARTMENT'S PROPOSAL

The Department has reviewed the numerous comments regarding the enforcement provision of the rule proposed in the draft environmental impact statement (EIS). The following are the principal enforcement recommendations of the Department's final proposal:

- Change the ambient air quality standards from their current form to expressly enforceable standards (no change from draft EIS);
- Adopt the standards without limitation of enforcement measures (no change from draft (EIS);
- Limit the definition of "ambient air" to include only areas where the general public has access (change from the draft EIS).

Each of these recommendations is discussed in the following sections.

DEFINITION OF AMBIENT AIR

The Department's original proposal included a definition of "ambient air" which authorized the enforcement of ambient standards upon the property of a pollution source (draft EIS, p. 18). The proposed definition was based upon welfare concerns rather than on concerns for human health since plant workers are protected by Occupational Health and Safety Administration (OSHA) and state industrial health regulations.

These welfare concerns were (1) the potential buying up by owners of the source of land surrounding the source and (2) the protection of wildlife on the property of the pollution source, (draft EIS, p. 18). At present,

there is little indication that either of these problems is widespread. While developments in these areas will be monitored, they do not now compel the inclusion of on-site enforcement of ambient standards. The Department has determined that the need for protection against such potential developments is outweighed by the increased compliance burden which potential on-site liability would be likely to have for stationary pollution sources in the state. Therefore, the rule now proposed by the Department does not authorize on-site enforcement of ambient standards. In this regard, it is identical to the federal EPA definition for ambient air.

The proposed definition of ambient air would not affect the inspection authority provided to the Department in the Montana Clean Air Act and the Montana Air quality rules. The Department retains its authorization to require and/or conduct on-site monitoring and to enter on-site areas for the purpose of making tests and verifying information.

ENFORCEMENT OF AMBIENT AIR QUALITY STANDARDS

Proscriptive; Prescriptive

A key concept in understanding the enforcement of ambient air quality standards is the difference between proscriptive and prescriptive pollutant regulations. A proscriptive regulation has the force of law and forbids the accumulation of a pollutant beyond a certain concentration. If the allowable concentration is exceeded, an enforcement agency is authorized to take action to reduce pollutant levels. Generally speaking, a regulation adopted as a "standard" is proscriptive.

A prescriptive regulation suggests pollutant levels toward which pollution control efforts are to be directed. It may be expressed either as a goal to be attained by a certain time or as a guideline to be reached eventually.

In either case, the prescribed goals or guidelines are not enforced in the manner of regulations which forbid pollutant concentrations beyond an established level. Violation of measures adopted to implement the goal or guidelines may be grounds for enforcement action. But causing pollutant concentrations beyond the prescribed guideline generally does not constitute a violation. Generally speaking, prescriptive regulations are not "standards".

The existing Montana rule on ambient air quality includes reference to "standard," "criteria," "goals and guidelines," and "maximum permissible concentrations," Recently some question has arisen whether enforcement may legitimately result from violation of a rule which provides in part that its ambient standards are adopted as goals and guidelines. Therefore, it is presently unclear whether the ambient standards adopted in 1967 were intended to be proscriptive (and have the force of law) or prescriptive (merely goals, not to be enforced).

Ambient Air Quality Standards and Emission Standards

Some explanation of the relationship between ambient air quality standards and emission standards is also helpful in understanding the Department's proposal.

An ambient air quality standard, simply stated, is a legal expression of the maximum permissible amounts of pollutants allowed in the atmosphere. Ambient concentrations usually are measured as a specific maximum amount of pollutant to be allowed in a given volume.

Emission standards, by contrast, relate to the amount of a given pollutant emitted by a source. Compliance with ambient standards is monitored with devices which determine the concentrations of a given pollutant in the ambient air. Compliance with emission standards is monitored by measuring the amount

of a pollutant emitted from a smoke stack or other point of discharge. Both ambient air quality standards and emission standards are proscriptive.

Emission standards are the principal means by which pollution emitting operations are controlled. Increasing the stringency of an emission standard requires greater control of emissions thereby improving ambient air quality.

The emission standards governing control of air pollutants in Montana are included within the Montana Air Quality Rules, 16-2.14(1)-S1400 through 16-2.14(1)-S14086 of the Administrative Rules of Montana. The emission standards apply to both new and existing sources. New sources, in addition to meeting emission standards, are subject to other requirements including the best available control technology (BACT) requirements imposed by the Montana air quality permit rule.

CURRENT ENFORCEMENT PROVISIONS

Summary

The Montana Clean Air Act sets out the objectives and the authority for management of the state's air. The Montana Air Quality Rules were adopted to implement the Act. The enforcement of these rules is the center of the state's air quality program.

There are approximately twenty-five rules pertaining to air quality in the Administrative Rules of Montana. Examples of these rules are those on air quality permits, open burning restrictions, equipment malfunction, prevention of significant deterioration (PSD), ambient air quality standards, and several rules imposing emission standards on sources which emit specific pollutants such as sulfur oxides, particulate matter, and fluorides.

The basic enforcement provisions of the Montana Clean Air Act are found in three of its sections. Section 75-2-401 (Enforcement) sets out various

administrative measures by which the Department is to enforce all rules established under the Act. Enforcement remedies provided in this section are orders to take corrective action, orders to appear before the Board, and the seeking of civil or criminal remedies under section 75-2-412 and 75-2-413. Section 75-2-401 also authorizes the use of warning, conference or other means appropriate to obtain voluntary compliance with ambient standards.

Section 75-2-412 authorizes the Department to seek criminal penalties in District Court and Section 75-2-413 authorizes the Department, in lieu of criminal penalties, to seek civil penalties in District Court. Both sections provide that court imposition of criminal or civil penalties is not a bar to enforcement of rules or orders by injunction or other appropriate civil remedies.

Ambient Air Quality Standards Rule

As noted above, one of the rules to be enforced sets out the ambient air qality standards for the state. Since sections 75-2-401 (enforcement), 75-2-412 (criminal penalties), and 75-2-413 (civil penalties) expressly apply to all rules, without exception, the rule on ambient standards is enforceable by any enforcement measure provided in these three sections of the Act. Therefore, unless the Board, in adopting the new ambient rules, took affirmative steps to limit the applicability of sections 75-2-401, 75-2-412, and 75-2-413, the newly adopted rule would be enforceable by any means provided in these three sections.

ENFORCEMENT ALTERNATIVES

There is no universally approved method of implementing and maintaining ambient air quality standards. In the sections which follow, the Department discusses the measures available to enforce the rule, and certain enforcement

alternatives which were suggested in response to the draft EIS.

There are two basic considerations which pertain to enforcement of the rules on ambient air quality standards. The first is whether the rules should establish goals and guidelines (prescriptive) or standard (proscriptive). Secondly, if they are to be proscriptive, some consideration must be given to the specific measures available to enforce them. These two considerations are viewed by the Department as follows.

Goals and Guidelines; Standards

1. Suggested Alternative A: No Action - One possible avenue suggested in comments to the draft EIS is simply to let stand the existing section 16-2.14 (1)-S14040 which uses several conflicting terms interchangeably, and leaves confusion as to whether Montana's ambient air quality standards are enforceable or merely "goals and guidelines." In the Department's view, the "no action" alternative would not resolve the ambiguity regarding the enforceability of the ambient air standards rule. One of the express purposes of the ambient air quality standards project was to dispose of questions concerning the original interpretation of "standards" in the 1967 rule. The no action alternative would allow these questions to stand until they were resolved in court or in some other official forum with costs in time, effort and funds. Consequently, the Department does not perceive the no action alternative as a feasible option for the Board.

2. Suggested Alternative B: Clarifying Amendments - Another enforcement alternative suggested in response to the draft EIS was the establishment of unenforceable goals and guidelines specifying maximum allowable pollution concentrations. By specifying that the goals and guidelines would not be enforceable, the Board would remove the ambiguity regarding the role of the

ambient rule in the air quality program. If the Board desired, the rule could be adopted to specify the role such goals and guidelines were to play in the setting of emission standards, the role of the Department in pursuing such goals, and the long-term objectives of the state's air quality program.

The Department views the adoption of the goals and guideline alternative as both unlikely and undesirable. As noted in the draft EIS, the Board's directive to initiate the ambient standards project arose from the discovery that the ambient rule was of questionable enforceability. It is therefore highly doubtful that the Board would adopt standards not carrying the force of law.

Furthermore, an ambient air quality rule with the force of law is, in the Department's view, preferable to unenforceable guidelines. The pollutant limitations presently proposed by the Department as ambient standards were determined on the basis of scientific information to provide air qulaity compatible with the public health and welfare. The recommended standards therefore are the foundation for the air quality program and are appropriately cast as maximum acceptable concentrations rather than unenforceable objectives.

The Department recognizes that an enforcement program probably could function with an ambient rule establishing only goals and guidelines. Technically, the Board has the authority to control pollution regardless of whether the state's ambient air quality reules establish goals and guidelines or standards. The Board is entitled to pursue "objectives" as intensely as it would act to enforce "standards."

However, as a matter of policy, the Department recommends a more immediate regulatory relationship between ambient standards and actual air quality in the state. Where ambient standards rather than guidelines are in force, no

questions could be raised concerning the vigor with which improved air quality was being pursued or whether a specified air quality level was worthy of pursuit. Most importantly, no question could be raised as to whether a violation of a "guideline" could serve as the basis for any administrative or judicial response to prompt compliance.

In sum, both in the interest of regulatory certainty and of assuring maintenance of scientifically based air quality levels, the Department recommends adoption of an ambient rule establishing standards rather than goals or guidelines.

3. Conclusion - For reasons of policy and practicality, the Department finds both suggested alternatives A and B undesirable. Furthermore, the Department does not view the adoption of enforceable goals and guidelines as consistent with the mandate in section 75-2-202 of the Montana Clean Air Act that the "The Board shall establish ambient air quality standards for the state." As explained earlier, regulatory standards do not merely suggest limitations on human activity but forbid such limitations from being exceeded. Standards therefore are proscriptive while goals and guidelines are prescriptive. Since the Legislature requires the Board to establish ambient air quality standards, the adoption of goals and guidelines would not fulfill the requirements of the Montana Clean Air Act. Therefore the Board does not have the option of adopting either of the suggested alternatives, A and B, as suggested by the respondents to the draft EIS.

Enforcement Measures Provided in the Montana Clean Air Act: Alternative C

Having discussed whether the ambient rule would establish air quality standards or goals and guidelines, the Department now turns to the second major

consideration pertaining to the enforcement of the ambient rule--the specific measures available to the Department for enforcement of the rule.

As noted previously, unless the Board, in adopting the ambient rule, were expressly to limit the applicability of sections 75-2-401, 75-2-412, and 75-2-413, the Department could enforce the rule by all measures provided in these three sections. Furthermore, although not an enforcement measure as such under the Montana Clean Air Act, the adjustment of emission standards by the Board is often an effective response to violations of ambient standards. Therefore, adoption of a rule with this full complement of enforcement measures may be summarized as follows.* For purposes of discussion, the Department refers to this full complement of enforcement measures as Alternative C.

Alternative C. Upon occurrance of a violation, the Department could pursue the following enforcement avenues:

1. Issue a notice of violation and an order to take corrective action to come into compliance with the ambient standards (order becomes final within 30 days unless person named applies for a Board hearing); or
2. Issue a notice of violation and require the person named to appear at a Board hearing to answer charges in the notice; or
3. Seek criminal penalties in District Court (up to a maximum of $1,000 per day); or
4. Seek civil remedies in the District Court (appropriate orders and/or fines up to a maximum of $10,000 per day);

*The discussion assumes that the Department may always seek voluntary compliance by use of warning conference, or other appropriate means, as provided in section 75-2-401(4).

5. Recommend adoption of an adjusted emission standard.

Under the alternative recommended by the Department, a full complement of enforcement measures would allow the Department to respond to any of the possible violations of the rule with maximum effectiveness. In this way, maintenance of ambient air quality standards would be most fully assured.

Each of the enforcement measures provided by the Legislature is a necessary and effective enforcement tool for the Department. The following considerations illustrate how each of these measures functions in the discharge of the ambient air quality responsibilities of the Board and the Department.

1. Administrative Orders (section 75-2-401)

   a. Order to take corrective action

   b. Order to appear before the Board

Administrative orders are a very effective enforcement device which allow resolution of noncompliance cases before a citizen board and are often preferable to judicial resolutions of noncompliance matters. Section 75-2-401 establishes rather formalized processes which use the technical and administrative experience of the Department and the Board to respond promptly and thoroughly to ambient violations. Administrative orders can be aimed at the specific nature of violations and unique situations of the sources causing violations. Such orders often require the source to take action within specific periods of time, and usually require the filing of progress reports. Department orders may be appealed to the Board where information concerning the violation and the order may be presented by either the Department or the source under order.

2. Judicial Remedies (sections 75-2-412, 75-2-413).

   a. Request District Court to impose civil penalties.

   b. Request District Court to impose criminal penalties.

   c. Injunction or other appropriate civil remedies.

The Department's authorization in sections 75-2-412 and 75-2-413 to seek civil or criminal remedies in District Court is central to the effective enforcement of ambient standards. In the first place the option to seek court intervention is necessary to protect the administrative orders of the Board. If a Board order is ignored, the Department should be able to pursue either civil or criminal remedies in court to enforce the Board order. Without the availability of these remedies, sources would have less incentive for expeditious compliance with Board orders and the Board would have little recourse in following up its orders.

Another expressed purpose in section 75-2-412 and 75-2-413 is to authorize the Department to seek civil or criminal remedies for violation of Board rules. These sections make no exception for the rule on ambient air quality standards. It is this authorization to seek remedies for a violation of the ambient rule which makes the ambient rule "directly enforceable." That is, if the emissions of a source caused a violation of an ambient standard, the Department could, on that basis alone, request the court to subject the source to either a civil or criminal penalty or to issue an order to comply with the standards.

Criminal penalties, while they do provide incentivies for future compliance, are limited in their usefulness because they do not specifically address the causes of ambient violations.* As a limited measure, a criminal penalty does not serve the primary objective of Departmental enforcement which is compliance with the ambient standards and so is likely to be used only under extreme circumstances.

By contrast, civil remedies typically sought by the Department would serve to promote compliance with ambient standards. With few exceptions, the Depart-

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*Any fines collected under sections 75-2-412 and 75-2-413 are paid to the state's general fund.

ment's request for civil remedies would first and foremost request a court order to the source to correct the noncompliance. Such orders look to the future and would obligate the source to undertake a compliance program, thus serving the Department's primary objective of ending the noncompliance. Furthermore, the Department could also request a civil penalty to compensate the public for past violations of the ambient standards. In this light, the civil remedies afforded by the Montana Clean Air Act are more useful as a corrective device than as a punitive measure.

3. Conclusion. The Legislature granted the Department and the Board the authority to issue administrative orders to enforce rules adopted by the Board. Furthermore, it has provided the Department with the authority to proceed judicially against those who violate Board orders and rules. Each of sections 75-2-401, 75-2-412, and 75-2-413 is important to the enforcement of ambient air quality standards.

Other Enforcement Alternatives

1. Availability of Other Alternatives. Since Alternative C includes all the enforcement measures provided by the Montana Clean Air Act, any other alternatives would necessarily lack one or more of the enforcement measures found in the Act. However, the Department finds no authorization in law for the Board to adopt an ambient rule in any way limiting the applicability of the specific enforcement sections provided in the Act.

The Legislature has provided these administrative and judicial mechanisms to enforce, without exception, all rules adopted under the Act. A waiver of any or all of these enforcement provisions by the Board would be inconsistent with the express legislative grants of authority and would frustrate the purposes of the Act. Therefore, the Department concludes that Alternative C, which includes all the enforcement provisions in the Act, is the only alternative legally available to the Board.

Although the Department considers Alternative C as the only alternative available, several industrial commentators to the draft EIS suggested that the Board should enforce ambient standards only through emission standards. In view of the number of suggestions to this effect and in order to make as complete a presentation of suggested alternatives as possible, the Department provides the following discussion of emission standards as a mechanism for enforcing ambient standards. As is apparent from the discussion, the exclusive use of emission standards to enforce ambient standards would be an undesirable enforcement approach, even if it were an alternative available to the Board.

2. Suggested Alternative D: Enforcement of Ambient Standards only Through Emission Standards. Several comments filed in response to the Department's proposal in the draft EIS suggested that ambient standards be enforced only by means of adjusting and enforcing emission standards. Under this approach, if an ambient air monitor indicated that an ambient standard had been exceeded, the Department would determine whether the source(s) in the area were in full compliance with the applicable emission standard. If the source(s) were not in compliance with the emission standard, the Department could proceed to enforce the emission standard by administrative, judicial, or other means, as provided in sections 75-2-401, 75-2-412, 75-2-413.

If on the other hand the area source(s) were in compliance with the emission standard, then the source(s) would not be potentially liable for ambient violations. In such a case, the only enforcement response would be a reassessment by the Department of the emission standard itself. In cases where there are ambient violations despite full compliance with emission standards in the area, the likelihood is that the emission limitation is not sufficiently stringent to assure that emissions will not exceed the ambient standards. Therefore the emission standard should be modified, typically made more stringent, to

require further emission reductions to the degree necessary to maintain ambient standards. This modification of emission standards would be accomplished by Board rulemaking.

If ambient standards were enforced only through emission standards, the enforcement options of the Department would be substantially limited. If the Department believed an ambient violation was occurring, it could not:

a. Issue any administrative orders. The source would have to violate an emission standard before the Department could issue either an order to take corrective action or an order requiring the source to appear before the Board.

b. Pursue any judicial remedies. The source would have to violate an emission standard before the Department could request the district court to impose either civil or criminal remedies.

Without these enforcement options, the ambient rule would not be "directly enforceable" but would be indirectly enforced through the enforcement of emission standards.

It is true that the implementation of ambient air quality standards through the enforcement of emission standards can be effective in many cases. There is no doubt that in Montana the enforcement of emission standards will continue to play a central role in achieving and maintaining necessary levels of ambient air quality. However, there are situations where the availability of administrative and judicial remedies (direct enforcement) to enforce ambient standards is especially useful.

For example, air quality is often threatened by fugitive emissions which are not emitted through a stack. Sources such as settling ponds, slag piles, roads, industrial furnaces, and the like may significantly affect air quality.

Not only is it difficult to formulate emission standards for such sources, but it is often difficult to measure with accuracy their total emissions. Ambient readings are not subject to the uncertainty associated with emission data from such sources. In cases where emissions are difficult to regulate or measure, administrative and judicial remedies should be available.

Ambient standards also are especially useful where major sources are geographically isolated. Generally, monitored violations of ambient standards in such cases may easily be traced to the one major source in the area. The availability of administrative and judicial remedies along with enforcement of emission standards would afford the Department an effective range of options for dealing with compliance by such sources.

There is another drawback to total reliance upon emission standards for ambient enforcement. As noted above, where an ambient violation occurred despite full compliance with emission standards, the only enforcement response for the Department would be to reassess and modify the emission standard to assure compliance with the ambient standard.

Often, reformulation of an emission standard is a substantial undertaking requiring significant time and technical information and Board rulemaking. During this process, the Department would largely be unable to take even interim action against a source which was causing ambient violations if the source remained in compliance with emission standards. The potential for prolonged or repeated ambient violations without any Board recourse to protect human health is undesirable and should be avoided.

Conclusion

For the reasons presented above, the Department concludes that the rule on ambient air quality standards to be adopted by the Board will be enforceable through all of the provisions specified in the Montana Clean Air Act.

The suggested enforcement approaches designated as Alternatives A and B, which would establish unenforceable goals and guidelines, would not carry out the Act's express requirement that the Board establish ambient air quality standards. Furthermore, any suggested alternative which would limit the applicability of the Act's enforcement provisions would prescribe an enforcement policy substantially different than that specifically established by the Legislature. Therefore, the enforcement approach designated as Alternative D is not available to the Board.

Legal considerations aside, limitations upon the available enforcement measures can be predicted to detract from the success of the Department and the Board in assuring that ambient air quality standards are maintained. Therefore, even if enforcement approaches other than Alternative C were available to the Board, the Department could not recommend them as feasible alternatives.

V. ANTICIPATED IMPACTS OF THE DEPARTMENT'S PROPOSAL

INTRODUCTION

The impacts of the proposed ambient air quality standards would occur in two broad categories: (1) a reduction in the effects of air pollution upon humans and the natural environment, and (2) economic and environmental costs resulting from efforts to achieve the air quality standards.

There are two fundamental constraints upon the Department's ability to predict the exact impacts of its proposed ambient rule. The first is the important role played by the existing regulatory background. Particularly with respect to new sources, current pollution control programs may largely determine the abatement requirements to be applied to pollution sources.

Secondly, it is difficult to quantify the impacts of the proposed standards either as costs (additional control of emissions) or benefits (reduced effects on humans, plants, animals and the environment). For this reason, the discussion on anticipated impacts is largely cast in qualitative rather than quantitative terms.

IMPACTS WITHIN EXISTING REGULATORY BACKGROUND

Any discussion of the impacts of the proposed standards must take into account the existing regulatory background within which the proposed ambient rules must operate. The impacts of the proposed rulescan be estimated only after reference to the principal elements of existing regulations:

- Existing Ambient Air Quality Standards
- Montana air quality regulations

- New Source Performance Standard (NSPS)
- Nonattainment provisions applying to areas in violation of federal air quality standards
- Prevention of Significant Deterioration (PSD)

Each of these elements merits some discussion.

Existing Ambient Air Quality Standards

There are two sets of ambient air quality regulations which already apply to pollution sources in Montana. These are the National Ambient Air Quality Standards (NAAQS) and the Montana rule on ambient air quality standards found in the Administrative Rules of Montana.

National Ambient Air Quality Standards (NAAQS). The National Ambient Air Quality standards were established by Congress in 1970. These standards apply across the nation. Currently there are standards for six pollutants with others to be set for different pollutants in the near future. There are "primary" standards designed to protect public health and "secondary" standards designed to protect public welfare.

Each of the states has been required to submit to the EPA a State Implementation Plan (SIP) to achieve and maintain the national ambient standards and to implement other federal air quality requirements. The Montana air quality regulations governing allowable emissions constitute the major component of the SIP. Since 1970, EPA has obliged the states to revise their state plans to reflect changing federal requirements, particularly those contained in the 1977 Federal Clean Air Act Amendments. The 1977 Amendments required in part that the state plans be revised to assure that the national primary ambient air quality standards (NAAQS) are achieved in every state by the new deadline of December 31, 1982. The Montana Board of Health submitted its latest revised plan to the EPA in April of 1979 and should soon have final approval for the plan.

Currently over one-half of the states have either formally adopted or use the national standards as their own state ambient air standards. Therefore, if adopted, the standards proposed by the Department would be among the more stringent state standards in effect.

The federal standards must be achieved nationally and therefore in Montana within a short time. Consequently, where the proposed state standards and the national standards are the same or nearly the same, there should be little or no impact on sources.* In such cases, achieving the national standard sources would also achieve the state standard. Table 1 indicates which proposed state standards are essentially the same as existing federal standards.

As Table 1 also reveals, some of the proposed Montana standards are somewhat more stringent than existing national standards. While these differences are numerically small, it does not necessarily follow that the impact of the proposed rule will also be small. Sometimes a slightly stricter standard can mean the difference between the onset of a health or welfare effect and the avoidance of those effects. In cases where the proposed standards are more stringent than the federal standards, some effects which may occur at concentrations allowed by the federal standard would be prevented by the proposed state standard. Some effects are possible at pollutant levels more dilute than the proposed standards.

By the same token, costs of controlling emissions are not always constant. At times the costs of controlling the last 20 percent of emissions can equal the costs of controlling the first 80 percent.

Therefore, only a slight tightening of an ambient standard can have a substantial cost impact, particularly for a facility that has reached the limit

*The Montana Clean Air Act contemplates a more comprehensive enforcement approach than that followed by the federal EPA.

of its installed control capacities in attempting to attain the national standards. Certain sources may incur expense in moving from federal compliance to compliance with the proposed standards. However, most sources in the state are expected to comply with the proposed standards with their current pollution control programs.

Montana Ambient Air Quality Standards. The Montana Clean Air Act specifically requires the Board to establish ambient air quality standards for the state. The Montana rule currently governing ambient air quality is one of the Department's regulations found in the Administrative Rules of Montana.

Pollution sources in the state have been subject to this rule since its adoption in 1967. Some of the air quality requirements in the rule have not been achieved although many sources in the state have initiated emission control programs to meet them. As noted earlier, it currently is unclear whether these ambient standards were intended to be enforceable standards or merely guidelines.

It is difficult to estimate the impacts of the proposed standards in light of the existing ambient rule. As Table 1 indicates, some of the proposed standards are different than those in the existing ambient rule. In cases where the proposed standards are the same or similar to the standards in the current rule, the proposals may be expected to have less of an impact than if they were being newly introduced into the state. Since adoption of the rule in 1967, sources in the state have been on notice that the Board has specified maximum permissible concentrations for the state. It is only recently that questions concerning their precise enforcement status have arisen.

On the other hand, the adoption of a rule establishing the proposed ambient standards and eliminating any reference to goals and guidelines would remove the

ambiguity surrounding the enforcement status of the existing rule. In that sense, the proposed rule would constitute a tightening of air quality regulations in the state, even though many of the proposed ambient requirements were adopted in 1967. For some existing facilities there may be increased compliance costs when the ambient limitations in the current rule are adopted as standards.

On the other hand, adoption of the proposed rule should result in a greater reduction in health and welfare effects than provided by either the national standard or the current state rule. It is obvious that proposed state standards more stringent than existing standards would provide more reduction in pollutant impacts than less stringent standards. However, increased protection would be provided even in the proposed standards that are the same as the federal standards or the current state rule, because of the more effective administrative and judicial enforcement features.

Montana Air Quality Regulations

The Montana air quality regulations forbid the operation of most significant air pollution sources in the state without an air quality permit. Permits for new or newly altered sources are granted only in cases where the source will install best available control technology (BACT). Therefore, for every new or altered source requiring a permit, the Department determines the maximum degree of pollution control which is achievable, taking into account energy demands, environmental and economic costs.

The regulations also include several emission standards for specific pollutants such as sulfur oxides, particulates, and fluorides. These regulations apply to both new and existing sources. In some cases, a particular emission standard may already require controls sufficient to allow compliance with the proposed ambient standards. In such cases, the proposed standards would not be likely to have a significant impact.

In other cases, emission standards may not be stringent enough to provide compliance with the proposed standards. In these cases, the proposed standards could have an impact on an existing source by expanding the source's responsibility to include achieving and maintaining necessary ambient air quality in the area.

Emission standards should correspond at least generally to ambient air quality standards. The Department will ensure this relationship through a gradual review of the state's emission standards for comparison with the ambient standards.

New Source Performance Standards (NSPS)

One aspect of regulation affecting industrial development is the new source performance standards program now incorporated into the Montana Air Quality Regulations as Section 16-2.14(1)-S14082 (Standards of Performance for New Stationary Sources). The regulation imposes minimum emission controls upon 28 categories of new or modified industrial sources.

The performance standards require new plants to use the best system of emission reduction which the federal Environmental Protection Agency has determined has been adequately demonstrated. Performance standards are scheduled to be issued in the next few years for most significant industrial categories.

Since the new source performance standards are applied nationwide, a given type of source would be required to attain the specified level of control no matter where it was built. Such a program would largely offset the economic advantages of being located in a state with ambient air quality standards less stringent than in other states.

In some cases it is likely that the proposed ambient standards could require more stringent controls than necessitated by new source performance standards.

However, in many cases current Montana law other than air quality requirements could require new sources to install controls beyond those required by new source performance standards. For example, the existing emission standards and the permit requirement for best available control technology may in some cases already require a level of emission control beyond the minimum design control set out in the new source performance standards. In such cases, the proposed ambient standards are not likely to impose further controls. Actual control requirements and the application of specific regulations which require them will be determined on a case-by-case basis.

Nonattainment

Another provision of the federal Clean Air Act Amendments of 1977 dealt with areas not in compliance with the national ambient air quality standards.

By the original deadline for achievement of the national ambient air standards (July 1, 1975) more than one-half of the nation's air control regions were still experiencing monitored violations. EPA then required the states to identify all areas which had not yet attained either the federal primary or secondary standards. The areas currently designated nonattainment in Montana are:

Table 5 Nonattainment Areas in Montana

	Carbon Monoxide (CO)	Total Suspended Particulate (TSP)	Sulfur Dioxide (SO_2)
Anaconda area			X
Billings Area	X	X	
Butte Area		X	
Columbia Falls		X	
Colstrip Area		X	
E. Helena Area		X	X
Great Falls Area		X	
Laurel Area			X
Missoula	X	X	

Subsequently, the EPA required the states to revise their state implementation plans to achieve reasonable further progress each year in such areas and to allow new growth in such areas only if stringent conditions were met. Therefore, existing sources in nonattainment areas must reduce their emissions to achieve reasonable further progress and, by the end of 1982, actual compliance with national standards. In addition, new sources proposed for location in nonattainment areas must attain a very high degree of control, known as "the lowest achievable emission rate" and must offset their projected emissions by obtaining emission reductions from sources already in the area (the so-called emissions offset). Those reductions must exceed the amount of emissions to be produced by the new source. Montana regulations currently impose such conditions.

The impact of the proposed ambient standards in nonattainment areas is subject to a number of variables. Generally speaking, emissions in such areas already are subject to further reduction. Therefore, to the extent that these reductions are prompted by nonattainment requirements, the proposed ambient standards will have little or no effect. In a few cases, controls beyond those being undertaken for compliance with a national standard may be necessary for compliance with a proposed Montana ambient standard. The proposed ambient standard thus may cause some impacts that otherwise would not occur.

Prevention of Significant Deterioration (PSD)

While the objective of the nonattainment provisions is to attain the national ambient standards, the fundamental purpose of the PSD requirements is to prevent the degradation of air already cleaner than required by the national standards.

The PSD regulations have been incorporated as part of the recently revised Montana implementation plan. They establish a system whereby areas of the

state with air quality better than national ambient standards remain at such relatively clean levels, unless state or local decisions change their status.

Three land classifications are defined: In Class I areas, only minimal pollution increments will be allowed over baseline levels; in Class II areas somewhat higher increments, consistent with moderate growth and development will be permitted; in Class III areas pollution levels may increase up to current national ambient standards. Initially, the entire state was designated Class II except for special areas such as wilderness and national parks, which Congress designated mandatory Class I. Also, the Northern Cheyenne Indian Reservation in eastern Montana has been redesignated as a Class I PSD area. Except for mandatory Class I areas, there are established procedures for redesignation of an area from one class to another.

The current regulations apply to twenty-eight (28) categories of "major" new or modified sources. A source is "major" if it has the potential to emit (after the application of control equipment) 100 tons per year of any pollutant regulated under the federal Clean Air Act.* New or modified sources not within the twenty-eight (28) categories are covered if they have the potential to emit (after the application of control equipment) two hundred-fifty (250) tons per year of any such pollutant.*

The PSD regulations currently apply to only two pollutants, sulfur dioxide and particulate matter. At present, the Environmental Protection Agency is developing PSD regulations for all pollutants for which there are national ambient air quality standards.

The basic principle of the PSD regulations is simple. A major new source or major modification may not be constructed unless the owner first obtains a

*Proposed modification to Federal PSD regulations in response to recent U.S. Court of Appeals decision in Alabama Power Co. vs. Costle.

permit requiring the source to apply best available control technology (BACT) and to meet other requirements. One of these requirements is that the new source will not exceed the increments allowed over the pollution baseline level. The allowable increases over the baseline are as follows:

MONTANA RULE ON PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

Allowed Increase Above Baseline Levels

	Fed. Std.	Proposed Mont. Standard	Class I Allowable Increment	Class II Allowable Increment	Class III Allowable Increment
Particulate					
24-hour (ug/m^3)	260	200	10	37	75
Annual	75	75	5	19	37
Sulfur Dioxide					
1-hr (ppm)	--	0.50	--	--	--
3-hr (ppm)	0.50	--	0.01	0.20	0.27
24-hr (ppm)	0.14	0.10	0.002	0.035	0.07
Annual (ppm)	0.03	0.02	0.0008	0.0008	0.016

The allowable increments are defined in terms of increases in pollution levels over the "baseline concentration." The baseline concentration reflects pollution levels existing in an area at the time the first application for a PSD permit is filed in that area by a major source.*

For large areas of the state, the PSD rule in effect establishes ambient sulfur dioxide and particulate standards more stringent than those proposed by the Department. For example, in a Class II area with sulfur dioxide concentrations near zero, the ambient standard under the PSD rule would be near 0.035 ppm 24-hour average, rather than the Department's proposed 0.10 24-hour average. Therefore, with the PSD rule in its current form, the Department's proposed standards for sulfur dioxide and particulate matter would have a negligible impact in large areas of the state. For example, the PSD rule rather than

*Proposed modification to Federal PSD regulations in response to recent U. S. Court of Appeals decision in Alabama Power Co. vs. Costle.

the proposed standards would largely determine the levels of sulfur dioxide and particulate that would be allowed in the ambient air surrounding future coal development facilities.

Nevertheless, the PSD rule could be weakened in the future to the extent that the Montana ambient standards might be required to ensure the maintenance of acceptable air quality in the area now controlled by the PSD rule. For the moment, the proposed standards ensure acceptable air quality for the entire state.

OTHER IMPACTS

Economic and Environmental Costs and Benefits of the Proposed Standards

Introduction The Department took two measures in order to assess as completely as possible the economic and environmental impacts of its proposals. First, it gathered and reviewed all the information pertinent to possible costs and benefits of its proposed ambient rule. This information included emission data, ambient air quality data, reports on current control programs, and the like. Secondly, the Department awarded a research grant to faculty at the University of Montana (Otis, *et al.*) to perform an economic analysis based largely upon the information provided by the Department.

The study by Otis *et al.*, "Some Economic Aspects of Air Pollution in Montana," is the principal reference used by the Department in making its assessments. The Department combined its own findings with the conclusions reached in Otis, *et al.* to identify the major areas of concern and to estimate the major costs and benefits of its proposal.

Summary The benefits of the proposed standards are the reductions of air pollution effects upon human health and welfare, while their costs are the

expenditures necessary to control emissions to comply with them.

The number of unknowns and variables relating to costs and benefits limited the depth of the Department's analysis. Sufficient information to even make estimates was available for only two pollutants, sulfur dioxide and fluoride.

Overall, the Department estimates that the benefits of achieving the proposed sulfur dioxide standards are roughly equal to the benefits to be gained. The Department also concludes that the state's two major fluoride sources would not need further controls to meet the proposed fluoride standards.

Sulfur Dioxide The Otis, et al. study estimated the costs and benefits likely to result from one of the proposed sulfur dioxide standards. The study concluded that the control benefits of moving from the federal 0.03 annual standard to the state's proposed 0.02 parts per million standard were of approximately the same magnitude as the expected costs.

Benefits. The estimated benefits were based upon anticipated reductions in sulfur dioxide effects on human health (sickness and death), vegetation, materials, and visibility.

The study calculated the economic value of reducing the risk of sickness and death for three Montana cities. If sulfur dioxide emissions were reduced to achieve the federal standard (0.03 ppm), the estimated economic value of reduced risk of health effects on residents of Billings, Anaconda and Helena would range from $1 million to $4 million per year. If sulfur dioxide emissions were reduced from their present levels to achieve the proposed Montana standard (0.02 ppm), the reduction in risk of sickness and death would have an estimated economic value ranging from $1 million to $7 million.

Sulfur dioxide can damage crops (such as alfalfa and wheat), timber, and ornamental plants (such as private and public gardens, and roadside trees).

Otis *et al*. estimated economic losses to these types of vegetation for four Montana counties, Silver Bow, Deer Lodge, Yellowstone and Lewis and Clark. Estimated reductions in the economic damage to crops, timber, and ornamentals were $1 million per year for meeting the federal standard and approximately $1.2 million per year for achieving the state standard.

Damage to materials, such as paint and metals, was estimated to be reduced by approximately $100,000 per year if either state or federal standards were met. Annual average benefits of improving visibility (from reductions in particulate derived from sulfur dioxide) ranged from $100,000 to $1 million for achieving the federal standard and from $200,000 to $2 million for achieving the state standard. The estimated benefits of meeting the state standard include the estimated benefits of meeting the federal standard. Therefore, the total benefits of achieving the federal standard range from $2 million to $6 million per year. The benefits of moving current ambient levels into compliance with the proposed state annual standard range from $3 million to $10 million per year.

Costs The Otis *et al*. study also estimated the costs associated with meeting the federal and state annual standards. Costs were approximated for the seven largest sources of sulfur dioxide in the state. The analyses relied heavily on control cost estimates provided by the industrial sources.

The Anaconda Copper smelter is the state's largest source of sulfur dioxide emissions. The Environmental Protection Agency has determined that 86 percent control of process input sulfur is necessary for the smelter to meet the federal 24-hour primary standard. The construction of a second large sulfuric acid plant at the smelter at a capital cost of $21 million should result in compliance with both the annual and 24-hour average federal standards and also the proposed Montana annual standard. Assuming relative stability in the price of sulfuric

acid, the Company's cost for marketing sulfuric acid should not exceed $1 million per year.

In East Helena, the ASARCO lead smelter recently has undergone the installation of a new sulfuric acid plant at a cost of $40 million, and the company plans to raise the height of its blast furnace stack. These modifications are predicted to reduce sulfur dioxide emissions sufficiently to allow the plant to meet both the federal and state annual standards. If additional control were necessary to comply with these standards, the additional modifications required for air pollution control could cost approximately $2 million.

In the Billings area, the CENEX petroleum refinery is the major source of sulfur dioxide emissions. The company already has agreed to construct two new stacks and initiate several modifications in its process equipment to achieve the federal annual standard for sulfur dioxide. These modifications will cost approximately $5 million. Meeting the proposed Montana annual standard could require an additional $1 million expenditure.

The Exxon petroleum refinery in Billings could require additional controls to meet the Montana standard. Costs for these added controls could reach approximately $9 million although substantially less expensive control measures may be available. The controls needed by Montana Power Company's J. E. Corette 180 MW power plant to meet the Montana standard could costs between $7 million and $11 million, depending on the engineering difficulty. It appears that both the Corette power plant and the Exxon refinery could comply with the federal standard with their present controls.

Other sources of sulfur dioxide in Billings are the Conoco petroleum refinery and the Montana Sulfur and Chemical Company. It appears likely that the Conoco refinery would not require any further controls to meet either the federal or the state standards. Montana Sulfur already has agreed to spend

approximately $700,000 to raise its exhaust stack, which should allow the plant to meet both the federal and the state standard.

In overall terms, the costs to all sources of achieving the federal standard range from $4.2 million to $8.5 million per year. The costs of achieving the Montana standard range from $5.6 million to $14.4 million per year.

Conclusion According to Otis, et al., the best measure of the net economic efficiency of achieving the state standard is the difference in benefits and costs of moving from the federal to the state standard. The study estimates that the annual benefits of moving from the federal to the state standard would be between $900,000 and $3.8 million. The annual costs of meeting the state standard would be between $1.4 million and $5.9 million. Since the increases in benefits and costs are of comparable magnitude, the Department's recommendation of 0.02 ppm is the standard most likely to provide the best balance between social costs and social benefits.

It is unclear whether the Otis, et al. estimate of the relationship between costs and benefits of the annual standard also would hold true for the proposed 24-hour and 1-hour standards. It appears that any increases in costs necessary for sources to comply with either the 24-hour or 1-hour standard would be offset by health and welfare benefits of comparable value. However, substantially more information would be needed before such estimates could be stated conclusively.

Fluoride

The Anaconda Aluminum Reduction Plant. Located at Columbia Falls, the Anaconda Aluminum Company's aluminum reduction plant is the largest source of fluoride emissions in the state. The Otis et al. study

reports that from 1968 to 1977 the plant's fluoride emissions caused an estimated loss of 27 million board feet of timber with an approximate economic loss of $1,640,000. Furthermore, the study reports that approximately 77,000 acres of Glacier National Park have been subjected to elevated levels of fluoride.

Since 1974 the Company has operated under a variance from the state's emission standards for fluorides. During this time it implemented controls for its fluoride emissions. The Company presently is completing a major changeover of its production process at a cost of approximately $30 million. The new control process is designed to recover approximately 8,000 tons of aluminum fluoride annually producing an annual savings of $4.2 million to the Company.

The current control program is expected to reduce fluoride emissions from the plant from 2500 pounds per day to approximately 850 pounds per day. A further reduction to 400 pounds per day could be achieved but the additional capital cost of such a system might exceed $25 million with no significant resource recovery expected. It is unlikely that the environmental benefits that would result from these additional controls could justify their costs.

Otis *et al*. projects that the current control program would end violations of the existing 24-hour ambient rule for fluoride. A Department review of emissions data and related ambient air quality readings in the vicinity of the plant indicates that the current control program at the facility would allow compliance with the proposed 24-hour ambient standard for fluorides. Also, on the basis of its emissions review, the Department expects that the control program would achieve compliance with the proposed 30-day standard and the proposed forage standard. Therefore the fluoride standards proposed by the Department are not expected to impose costs beyond those already committed for the current control program.

Stauffer Chemical Company The Stauffer Chemical Company's elemental phosphorous plant has been a significant source of fluoride emissions near Ramsay, Montana. Evidence suggests that vegetation on 130,000 acres of agricultural land in the area has elevated fluoride concentrations. Otis et al. estimate that of these 130,000 acres, 42,000 acres of potential grazing land is affected by Stauffer's fluoride emissions resulting in an annual economic loss of $1 million.

The Company is currently completing a pollution control program which should reduce fluoride emissions from previous levels of approximately 340 pounds per day to approximately 110 pounds per day. Otis et al. project that this reduction in emissions should limit the facility's impact to not more than 12,000 acres with an annual savings of $700,000.

Otis et al. estimate that the cost for controlling emissions to less than 100 pounds would not exceed $2 million. Such modifications would probably limit the area of significant fluoride impact to less than 7,000 acres with an annual benefit of $500,000 in alfalfa production alone.

The current control program has only recently become operational. A Department review of past and projected air quality data in the vicinity of the plant indicates that the new controls should be capable of achieving substantial compliance with the proposed 24-hour hydrogen fluoride standard. The review strongly suggests that the control program will also achieve the proposed 30-day hydrogen fluoride standard and the proposed standard for fluoride in forage. On site investigation of the control effectiveness is on going and final results should be available by May 1, 1980.

Conclusion Otis et al. estimate that the current control program at the Anaconda Aluminum plant will eliminate fluoride damage to Glacier

National Park and reduce the timber losses by more than one-half. The new control program at Stauffer Chemical is expected to reduce the impact of the plant to roughly 12,000 acres, thereby avoiding crop destruction on some 30,000 acres.

The current control programs at both the Anaconda Aluminum plant and the Stauffer Chemical facility are expected to achieve compliance with the proposed standards. Therefore the fluoride standards proposed by the Department are not expected to impose costs for emission control beyond those already committed by these sources.

Growth Inducing and Growth Inhibiting Impacts

Growth Inducing Impacts The proposed standards are intended to achieve and maintain air quality sufficient to protect the human and natural environments, thereby enhancing the productivity of both.

Standards based upon health considerations reduce the potential for human health effects. Lower potential for disease, fewer sick days, and the reduced potential for intereference with normal human activities may be expected to increase human productivity and enjoyment.

Farming and ranching, wood products and recreation, which together account for more than one-half the state's economic activity, all depend upon clean air. The proposed standards would contribute to preserving the productivity of these sectors.

In addition, much of the state's residential growth can be attributed to the natural amenities available in Montana, including its unpolluted air. The proposed standards, particularly those for the urban pollutants, visibility, and settled particulate should preserve these amenities and Montana's attractiveness as a place to live.

It is very difficult to provide quantitative estimates of the growth-inducing impacts of the proposed standards. In the first place, it is difficult to segregate the future role of the proposed standards from the contributions of other regulatory programs in preserving air quality. Consequently, the extent to which the proposed standards would induce the growth of air-quality dependent economic activity cannot be known.

Furthermore, a great deal of scientific research would be needed to estimate the total impact of the proposed standards upon productivity. For example, reducing the human population's exposure to chronic low-level pollution might have only minor benefits. On the other hand, the benefits of such protection could be large and therefore could greatly enhance the population's long-term productivity. Similar considerations apply to crops, forests, animals, and the natural environment.

In summary, the principal growth inducing impact of the proposed standards would be the protection of the health of the state's citizens and the preservation of the state's natural resources and amenities. The productivity flowing from these human and natural resources is thereby likely to be enhanced.

<u>Growth Inhibiting Effects</u> Generally speaking, growth might be inhibited to the extent that the costs of reducing emissions to meet the proposed ambient standards could discourage investment in existing or new facilities.

It should be noted that decisions to invest in existing or new facilities are usually based upon a number of factors including business trends, access to markets, labor and energy costs, and the like. The cost of complying with air quality standards is typically only one of those factors. Consequently, the extent to which the proposed standards would discourage investment is likely to vary from case to case.

Industrial Growth Existing Facilities Growth within existing facilities can occur either as increased production within existing design or as an expansion of the physical plant. Ordinarily either of these activities increases emissions.

- Increased production level

The impact of the proposed standards on increased production levels is likely to vary widely. Most larger facilities are subject to one or more emission standards and operate under the terms of an air quality permit. In most cases, increased emissions from stepped up production levels would be subject to one or both of these constraints. Further, significant production increases could result from modifications subject to either PSD or nonattainment restrictions.

This is not to suggest that the proposed standards would have no impact on decisions to increase production. The limits to growth imposed by current regulations are likely to be influenced by adoption of the proposed standards. For example, a decision by the Department to modify a permit to allow a proposed increase in emissions could largely be determined by the anticipated effects on ambient air quality.

In some cases the proposed standards could serve to place certain Montana industrial operations at a competitive disadvantage with facilities in other states with less stringent ambient air quality standards. If this competitive disadvantage is substantial, then the growth potential of some Montana operations could be impaired. Such instances are not deemed likely.

- Expansion of physical plant

With few exceptions, expansion of an existing facility would be subject to regulations already in force. Under the Montana air quality regulations, "new or altered sources" are subject to best available control technology

(BACT). In most cases, application of this technology would allow compliance with the proposed standards.

If the expansion constitutes a "major modification" under the PSD (prevention of significant deterioration) rule (and is in one of the 28 specified categories) then the expansion is subject to best available control technology and the allowable increments for sulfur dioxide and particulate matter. If the source undertaking a "major modification" is located in a nonattainment area then the expansion would be subject to lowest achievable emission rate and the offset requirements applied to nonattainment areas.

<u>Industrial Growth - New Facilities</u>. Since pollution control regulations are only one of the many influences affecting siting decisions, it is difficult to assess the impact of the proposed standards on future industrial growth.

Moreover, there are many regulations already operating to impose emission control requirements on new industrial facilities. Most new sources will be subject to one or more of the following regulations already in force: Montana emission standards, Montana permit rule requiring best available control technology, New Source Performance Standards (NSPS), Prevention of Significant Deterioration, and nonattainment regulations requiring lowest achievable emission rate.

In some cases, the proposed standards could require controls beyond those needed to comply with existing requirements. However, it is likely that the degree of pollution control required by one or more of these existing regulations would be sufficient to assure compliance of a new source with the proposed ambient standards. Moreover, the latter three regulatory programs have national application, largely offsetting any competitive advantages which the states may offer over each other.

Summary For some existing facilities, compliance with the proposed standards might require a reduction in emissions thereby diverting resources otherwise available to expand production or physical plant. In some cases, the proposed standard alone might determine whether a facility would remain operating or shut down. Such cases are not likely.

For new sources, the existing regulatory background and the fact that compliance with ambient air quality standards is only one consideration in an industrial siting decision make it likely that the proposed standards would have at most a minor impact upon future industrial growth in Montana.

Inhibition of other types of social and economic growth in the state is not expected to result from adoption of the proposed standards.

Unavoidable Adverse Environmental Impacts

Any pollution standards which allow any pollution whatsoever are likely to allow environmental effects which could be avoided by setting the standards to prevent even the smallest amounts of ambient air contamination. Air pollution emissions allowed by the proposed standards could be prevented by more stringent standards. It is possible that failure to propose more stringent standards could result in additional health effects, additional loss to vegetation, and additional accumulation of pollutants in the state's ecosystems.

However, the standards proposed by the Department are not designed to avoid all possible effects of air pollution. Standards based upon health considerations have included a margin of safety to account for possible unknown effects of air pollution on human health. Therefore, on the basis of current knowledge, adverse effects of air pollution upon the human environment should be avoided if the proposed standards are adopted.

Beyond considerations of human health, the Department has examined scientific evidence for known or anticipated effects of air pollution upon plants, animals and natural environments. There may well be effects upon natural systems which have not yet been detected. For example, chronic, low levels of pollutants may subtly interfere with soil microbes resulting in dramatic ecosystem consequences over time. Little is known about such phenomena. Until sufficient scientific information is available, the as yet undetected environmental effects of air pollution, if any, are unavoidable.

Irreversible Commitments of Resources

Any air quality standard which allows greater than zero discharge of pollutants will, to some extent, commit the ambient air to the function of waste disposal and dispersion. Any effects resulting from exposure of the human population or natural systems to unprevented air pollution may or may not be irreversible. Reliable scientific evidence in this regard does not yet exist.

In some cases, the proposed standards could necessitate the use of additional emission controls. Commitments of materials and energy would be required to build and operate such equipment. Also, increased removal of particulate and increased use of sludge producing scrubbers could require the use of additional land as disposal sites. Water withdrawn from local supplies to operate such scrubbers, and leachate from sludge disposal sites could adversely affect water quality and quantity.

There is little basis for estimating the extent to which the proposed standards could necessitate any of these commitments.

Short-term Uses and Long-term Productivity

In the context of ambient air quality standards, the local, short-term uses of the environment may be identified as the "use" of the ambient atmosphere as the receptacle for air-borne wastes resulting from human activi-

ties. Such use of the environment is not entirely objectionable. The natural, physical environment does have a capacity to absorb, disperse, and recycle some wastes with no permanent harm ensuing. It is this ability of the environment to maintain its regenerative characteristics, thereby providing continuing support for social and economic growth, which may be identified as the "long-term productivity" of the environment.

Short-term uses of the environment may carry short-term effects such as health impacts, damage to vegetation and materials, and aesthetic impacts, which may reach significant levels long before the environment's ability to restore equilibrium is threatened. However, as the volume and intensity of human waste-producing activities increase, the limits of the ecosystem's ability to handle such products may be reached or exceeded, at least in localized areas.

The long-term ecological effects of acid rain, for example, or the "green house" effect of excessive carbon dioxide levels are not yet well-understood, but the potential for long-term or permanent shifts in the ecological balance of a region or of the planet has been demonstrated. A precise weighing of the benefits of such short-term uses of the environment against the potential harm to the long-term "health" of the ecosystem is not generally possible. The Department's recommendations allow the short-term use of the air in a manner consistent with human health and welfare. Further scientific information is necessary to demonstrate what pollutant concentrations will interfere with the long-term productivity of the environment.

VI. CONCLUSIONS

This chapter contains a distillation of the Department's review of the scientific data, along with the rationale that went into determining the appropriate standards for each pollutant.

The Department reviewed the literature on the effects of sulfur dioxide on the public health and welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 49-112.

General Findings

Human Health

Sulfur dioxide and its oxidation products have been associated with adverse human health effects and adverse effects on vegetation. Sulfur oxides may irritate the throat and lungs and exacerbate existing respiratory disease. The growth and yield of timber, wheat, oats and other agricultural crops important to Montana is reduced by exposure to sulfur oxides.

Studies of the effects of sulfur dioxide on people have been of two distinctly different types. One group of studies exposed subjects to sulfur dioxide in the laboratory for relatively short periods of time usually a few minutes to a few hours. Another group of studies attempted to analyse the results of exposure under natural conditions by comparing the effects on individuals from several communities with differing pollution levels or by following the reactions of individuals within one community over a period of time. These community studies most often are based on measurements of the twenty-four-hour average or annual average concentrations of sulfur dioxide. A definite response to sulfur dioxide exposures has been observed in healthy young subjects after short-term exposures to concentrations of 0.75 to 3.0 ppm. Sensitive measures detected changes of lung function following exposure to 3 ppm of sulfur dioxide for less than 5 minutes (Kreisman et al. 1976), to 1 ppm for 15 minutes (Snell and Luchsinger 1969), and to 0.75 ppm for 90 minutes when subjects were exercising (Bates and Hauzucha 1973). A few

subjects among a group of fifteen reported discomfort and demonstrated a reduced mucous flow rate during an exposure to 1 ppm of sulfur dioxide over 1 to 6 hours (Andersen et al. 1974). Mucous flow is believed to be an important part of the body's defense against infection.

Exposures to mixtures of sulfur dioxide, particulates, and other pollutants found in the ambient air have been associated with aggravation of illness and an increase in death rates. In a review of several studies, Lawther (1963) concluded that an increase in the number of illness-related deaths had been observed when the daily average sulfur dioxide concentration was above 0.25 ppm and suspended particulate was in excess of 750 ug/m^3. In a separate series of studies, Lawther et al. (1970) analysed health records of elderly bronchitis patients. From these data he concluded that the minimum daily pollution level that would result in aggravation of the patients' condition was 0.19 ppm of sulfur dioxide and about 250 ug/m^3 BS* of particulate. However, in a follow up study a few years later he again observed health effects associated with sulfur oxides and particulates, even though the pollution levels were much lower. Similarly, a study of asthma patients observed a relationship between the frequency of asthma attacks and concentrations of sulfur oxides and particulates, without any distinct threshold (Cohen et al., 1972).

Studies of the long-term health effects of air pollution observed an increased death rate and increased respiratory diseases in more polluted areas. Douglas and Waller (1966) noted an increased incidence of bronchitis and colds in the chest among school children in areas with sulfur dioxide concentrations greater than 0.05 ppm annual average and suspended particulate levels greater than 132 ug/m^3 BS. An increase in the death rate was reported by Wicken and

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* BS refers to particulate measurement by the British Smoke method; see pp. 53-54 of the draft EIS.

Buck (1964) when annual average sulfur dioxide levels were at 0.04 ppm and suspended particulate at 160 ug/m^3 BS.

Kerrebijn et al. (1975) found an increased incidence of cough and chronic lung disease among children in an area with an annual average concentration of 0.06 ppm of sulfur dioxide and an annual average particulate matter concentration of less than 40 ug/m^3 BS.

Vegetation

Vegetation damage from sulfur dioxide has been recorded in Montana in the past (Scheffer and Hedgecock, 1955). The levels causing this damage are not accurately known. It may be assumed, however, that the concentrations of sulfur dioxide which caused past vegetation damage were higher than are presently occurring in the state.

Scientific studies have determined a range of adverse effects that occur in vegetation from sulfur dioxide either alone or in combination with other pollutants. Table III.A-III on pp. 79-83 of the draft EIS gives results from a number of these studies. The information depicted in Table III.A-III indicates several important facts: 1) that sulfur dioxide in combination with other pollutants can cause synergistic type vegetation damage 2) that environmental conditions of moisture and nutrition can alter plant response to sulfur dioxide 3) that sulfur dioxide levels of 0.02 to 0.5 ppm for one hour can cause measureable alterations in normal plant functions (it is not clear if such alterations are irreversibly detrimental) 4) that sulfur dioxide average concentrations between 0.5 and 0.1 ppm for four to 24 hours when combined with other pollutants cause an increase in leaf destruction 5) that annual sulfur dioxide levels below 0.03 ppm are associated with the elimination of certain lower plant forms and possible growth loss in non native forest species.

Sulfur dioxide enters into a number of chemical reactions in the atmosphere. The result of several of these reactions is the production of acids which may fall to earth as acidic rain, snow, or other forms of precipitation. Acid precipitation has been noted by scientists throughout the world to be increasing with increased utilization of fossil fuels for electrical power generation and industrial development (Shriner et al. 1977).

Acid precipitation has been shown to cause increased acidity in many lakes and in forest soils with concomittant losses in fish populations and forest yields (Dochinger and Selinga, 1976). The extent of potential and actual acid precipitation in Montana is not known.

Other Welfare Effects

Sulfur dioxide can cause significant damage to materials especally when sufficent humidity is present. Materials particularly suseptible to sulfur dioxide and its derivatives are paint, building stone, and both galvanized and untreated iron and steel. (Salmon, 1970).

Measurement of Sulfur Dioxide

Sulfur dioxide is routinely measured by the pararnosaniline method described in the draft EIS. This measuring technique has been prescribed by the EPA for the measurement of sulfur dioxide to determine compliance with the federal standards. It is accurate and reliable within the expected range of ambient concentrations.

Automated methods for the measurement of sulfur dioxide have been developed. The Air Quality Bureau is presently using certain of these techniques approved by the EPA as equivalent to the pararosaniline method, such as the Philips coulometric and the Thermal Electron pulsed fluoresence instruments. These methods are accurate and reliable within the expected range of ambinet concentrations.

Susceptible Populations

Several studies observed that about 10 percent of their subjects were especially sensitive to sulfur dioxide. In a study of the occurrance and development of chronic bronchitis, Fletcher et al. (1976) found that 13 percent of their sample was especially susceptible to the development of chronic obstructive lung disease.

It is not known if the persons who were particularly susceptible to lung disease represented the same portion of the population as the 10 percent who have been found to be sensitive to sulfur dioxide. Quite apart from these individuals, children and persons with existing respiratory conditions also are considered to be particularly vulnerable to sulfur dioxide. The National Center for Health Statistics (1973) reports that in the western U.S. approximately three percent of the population experience continuing asthma, one percent had emphysema, and three percent were chronic bronchitis patients. Among those over 65 years, approximately four percent had asthma, three percent emphysema, and four percent chronic bronchitis. Persons with chronic bronchitis who are over 55 years have been found to be more vulnerable to sulfur oxides pollution than younger chronic bronchitis patients (Carnow et al. 1969).

Level of Apparent Health Response

Based on the studies cited above, the Department identified 0.75 to 1.0 ppm of sulfur dioxide for one hour as likely to be associated with the response of decreased lung function measurements in sensitive but otherwise healthy populations 0.19 to 0.25 ppm of sulfur dioxide for twenty-four hours as likely to be associated with decreased physical capacity for exercise, and with death among persons with advanced heart and lung disease; and 0.04 ppm to 0.05 ppm of sulfur dioxide annual average with an increased incidence of respiratory disease among general populations, especially children.

Uncertainty and Risk

The primary effects on human health associated with exposure to sulfur dioxide (a decrease in lung function, an increased incidence of respiratory disease among children, a decline in the health of individuals with chronic obstructive lung conditions to and including death, and an increase in the number of asthma attacks among persons with asthma) present a risk to the health of a vulnerable population group in the community and may result in permanent damage.

The changes in lung function observed in brief, sporadic exposures to sulfur dioxide concentrations of 0.75 to 3.0 ppm appear to be entirely reversible in otherwise healthy individuals with exposure to clean air. In laboratory experiments repeated or continued exposure to such concentrations often results in an acclimatization such that the effects tend to diminish (Frank _et al_. 1962). This is thought to be due to an adaptation of the nervous reflex responsible for the effect.

Lung function gradually declines with age in all people. An individual who smokes or who has an obstructive lung condition will lose lung function at a faster than normal rate. Some diseases can result in a substantial decline in lung function, even among young people. There is no specific loss that marks the onset of chronic obstructive lung disease for each individual, but rather a gradual increase in poor health and limitation of activities due to shortness of breath is observed. Thus an additional loss in lung function from air pollution will simply increase the degree of disability at any age and lung capacity. Persons with already impaired lung function, such as an individual with chronic obstructive lung disease, could find their meager reserves of lung capacity severely eroded by even a small additional loss of lung function Under such circumstances a person might complain that they are not able to get enough breath for almost any exertion, even such a simple act

as feeding themselves. In many instances this also will place a strain on the heart.

An increased incidence of respiratory disease among children can have long-term as well as immediate adverse effects. Burrows et al. (1977) and others have observed that children with a history of respiratory disease are much more likely to develop chronic obstructive lung conditions when they are grown. As adults, these individuals also were reported as having a lower average lung function than individuals without a history of childhood respiratory disease.

An increased incidence of asthma symptons and asthma attacks increases the financial and health cost imposed by each such incident and increases the risk that an especially severe attack may be experienced. Such a severe attack can result in hospitalization and long-term or permanent health damage.

Substantial uncertaintly exists in the identification of a minimum concentration below which such human health effects do not occur. Laboratory studies of short-term exposures to moderate concentrations have relied almost entirely on healthy subjects, although some of these otherwise healthy subjects have proven to be sensitive to sulfur dioxide. Many of the studies of community health response have focused directly on the more sensitive segments of the population. This reduces the uncertainty in developing standards from these studies. However, several epidemiological studies of general populations have observed a relationship between reported health effects and sulfur dioxide and particulate pollution that increases from the lowest to the highest pollution levels without any apparent threshold. Some studies report a lower limit of exposure simply because their control group also is experiencing an exposure to sulfur dioxide. Other studies report an apparent threshold which may be due more to the size and composition of their sample than to any property of the pollutant.

Long-term studies of air pollution effects are difficult to interpret. Although a pollution level can be measured and associated with a group of individuals who are being observed, the effects may be partly due to exposures in past years that may have been higher either because the pollution has been reduced in the interim or the family has moved to a less polluted area. On the other hand, pollution levels may have been increasing as the economy and production have increased or the family may have moved to a more polluted area.

Synergistic Effects

Many epidemiological studies have been made in cities where both sulfur dioxide and particulate concentrations are high. It is not possible to say if the effects observed are greater from the sum of the effects from each pollutant separately. Although the effects are observed in situations with and without particulate matter present, it is not known if the effects are significantly increased by the presence of particulate matter.

Attempts to demonstrate the synergistic effect with laboratory animals have involved tests at high concentrations of sulfur dioxide and particulates (Asmundson et al., 1973). Amdur (1978) reported a synergistic response between sulfur dioxide and copper sulfate particles at moderate concentrations but has not observed synergism for other sulfate particulates. The mechanism of the synergistic effect in studies such as this is not known nor is it clear that a synergistic effect exists at low concentrations. In developing the standards, the Department's utilization of studies measuring both sulfur dioxide and particulate matter will assure that synergistic effects, if any, will be taken into account.

A few laboratory studies have observed synergistic effects between oxidants and sulfur dioxide, especially in the presence of low concentrations of particulate matter (Hazucha and Bates, 1975 and Bell et al., 1977). Other studies (Bedi et al., 1979) have not observed the synergism at the same concentrations.

Since ozone levels of the magnitude utilized in these experiments have never been observed in Montana and even moderate concentrations occur only infrequently, these synergistic effects were not taken into account developing the Department's recommendations. If they had been an element of consideration, the recommendations might have been revised toward a more stringent standard.

Recommended Standard - One Hour

The response observed from brief exposures to 0.75 to 1.0 ppm of sulfur dioxide is of minimal health significance in healthy populations. However, substantial uncertainty remains in identifying the concentration that will not adversely affect the health of individuals with currently impaired heart and lung function since experimental subjects typically have been healthy, young individuals. Therefore, to protect the health of vulnerable individuals and to protect the general public from five- to fifteen-minute exposures in the range of 0.75 to 1.0 ppm, the Department recommends an ambient air quality standard for sulfur dioxide of 0.5 ppm, averaged over one hour, not to be exceeded more than once a year.

The current Montana one-hour standard is 0.25 ppm, not to be exceeded more than once in any four consecutive days. The federal secondary standard is 0.5 ppm, averaged over three hours, not to be exceeded more than once a year. Although an exact equivalence cannot be stated, the present state standard might permit a one-hour exposure between 1 and 2 ppm, not to be exceeded more than once a year, at many locations in the state. Similarly, achievement of the federal standard can be estimated to permit a one-hour average exposure of between 0.6 and 0.8 ppm, not to be exceeded more than once a year, at most monitoring locations in the state. Although the one hour standard of 0.5 ppm could be expected to permit only one twenty-minute period to exceed 0.8 ppm during the year, a three-hour standard could be expected to

permit between two and five twenty-minute periods to exceed 0.8 ppm during a one year period at most monitoring locations in the state.

Twenty-four Hour Standard

The health responses observed in community studies from twenty-four-hour exposures to 0.19 to 0.25 ppm of sulfur dioxide often were most apparent when contemporaneous particulate matter concentrations were greater than 250 ug/m^3 BS.* However, in several studies described here and in the draft EIS, health responses were observed at significantly lower sulfur dioxide and particulate matter concentrations with no apparent threshold. At the lower concentrations the responses become less dramatic and more difficult to identify with statistical precision but are nevertheless observed. There is not convincing evidence that the presence of particulate is necessary to observe the effect at low concentrations. Therefore the Department concedes a substantial degree of uncertainty in the identification of a concentration that will clearly protect the public health and safety, and recommends an ambient air quality standard of 0.10 ppm averaged over twenty-four hours, not to be exceeded more than once a year.

The current Montana twenty-four hour rule is 0.10 ppm, not to be exceeded more than one day in any three month period. This is expected to be functionally equivalent to the proposed standard, since violations of air quality standards often occur only during a single season at most monitoring locations. The current Federal regulations require the State to achieve a standard of not more than 0.14 ppm, not to be exceeded more than once a year.

An averaging time of twenty-four hours is consistent with the time periods reported in the community epidemiological studies cited above and is consistent with the averaging time of the federal standards. An exceedance level of once per year, which is essentially a prohibition on concentrations above that amount, has been selected to be consistent with the other air qualtiy standards being recommended by the Department.

*BS refers to particulate measurement by the British Smoke method; see pp. 53-54 of the draft EIS.

Annual Standard

Studies of the long term effects of sulfur dioxide exposure have associated the observed health response with annual average concentrations of 0.04 to 0.05 ppm. In many of these studies, particulate matter concentrations are high where sulfur dioxide levels are high, and low where sulfur dioxide levels are low. Thus in these studies, the relative importance of the two pollutants cannot be clearly separated. Nor is it known if there is a synergistic relationship between sulfur dioxide and particulate matter at low concentrations. A few studies have observed similar health responses at similar or slightly higher concentrations of sulfur dioxide where annual average concentrations of particulate matter were very low. Because of the uncertainty involved in identifying the long term concentrations of sulfur dioxide that will not adversely affect health, the Department recommends an annual average standard of 0.02 ppm.

The current Montana annual average rule is 0.02 ppm. The current federal primary standard is 0.03 ppm annual average.

Consideration of Welfare Effects

The Department's review and analysis of current scientific evidence indicates that the standards proposed to protect human health should largely protect the state's commercially important plants from the known or anticipated effects of sulfur dioxide. Some potential exists for some sensitive species to be affected at concentrations allowed by the proposed standards. It is anticipated the effects of sulfur dioxide on materials, property, and other welfare interests would be prevented by the proposed standards.

The current evidence pertaining to the welfare benefits from more stringent sulfur dioxide standards than that needed to protect human health is inconclusive and leaves the Department without a sufficient basis to ascertain the extent and significance of harm at concentrations below those proposed. Until further

research clarifies these uncertainties, the Department has determined the proposed standards to adequatly protect welfare interests and therefore does not recommend standards beyond that needed to protect human health.

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TOTAL SUSPENDED PARTICULATE

The Department has reviewed a broad literature on the effects of particulate matter on the public health and welfare. The salient features of that literature were described in the draft Environmental Impact Statement at pp. 49-112 and pp. 183-188.

General Findings

Human Health

One of the most significant aspects of particles is their size. Few particles larger than 15 micrometers can be inhaled. Smaller particles will be carried deeper into the throat and lungs. As much as 35 percent of the 10 micrometer inhaled particles can reach the upper windpipe but only 5 percent will enter the lungs. Twenty-five percent of the one micrometer inhaled particles will be deposited in the lungs and 50 percent of the 0.1 micrometer particles will be deposited there (Task Group on Lung Dynamics, 1966). Thus the larger particles will tend to affect the nose, throat and upper windpipe and the smaller particles will have more effect on the lungs.

The size of particles is related to their origin. Particles that are created in the air from gases (such as sulfates from sulfur dioxide) are quite small. They are usually about 0.1 micrometers and almost always less than 2 micrometers. Similar particles are released from most combustion processes. Large airborne particles, usually about 15 to 20 micrometers but occasionally as small as one micrometer or as large as 100 micrometers, are principally of natural origin or the product of grinding or wearing mechanical operations. A portion of these particles often is less than 10 or even 5 micrometers and is thus capable of entering the human airways in significant numbers.

Particles may affect the throat and lungs either by their simple mass

(without regard to their composition) or because of a specific biological reaction to the chemicals they are made from. Particles also tend to collect gases and smaller particles on their surfaces, such that a relatively inert particle may have a surface that can cause a reaction. Although some laboratory experiments have measured the effects of particles of specific chemical composition, it is not known which of these three mechanisms (particle mass, chemistry, or surface adsorption) is primarily responsible for the effects observed in the more general community epidemiological studies. In all probability, each contributes to a different degree under varying circumstances.

Particulate sulfates (Amdur, 1966) and sulfuric acid mist (Amdur, 1978) have been observed to have a substantially greater effect on the lung function of laboratory animals than sulfur dioxide gas at equivalent concentrations. In these experiments some chemical forms of the sulfate particles produced a greater response than other forms. Other researchers have observed that inhaled particulate matter may interfere with the foreign matter removal mechanisms in the lungs of laboratory animals, thus prolonging the contact between pollutants and lung tissue (Saffiotti, 1972).

Exposures to mixtures of particulates, sulfur dioxide, and other pollutants found in the ambient air have been associated with aggravation of illness and an increase in death rates. In a review of several other studies, Lawther (1963) concluded that an increase in the number of illness-related deaths had been observed when the daily average sulfur dioxide concentration was above 0.25 ppm and suspended particulates were in excess of 750 ug/m^3. In a separate series of studies, Lawther et al. (1970) analyzed health records of elderly bronchitis patients. From this data he concluded that the minimum daily pollution level that would result in aggravation of their condition was 0.19 ppm of sulfur dioxide and about 250 ug/m^3 BS of particulate. However, in a subsequent

portion of the study he again observed the association between sulfur oxides and particulates and the subjects' health even though the pollution levels were much lower. Similarly, a study of asthma patients observed a relationship between the frequency of asthma attacks and concentrations of sulfur oxides and particulates, without any distinct threshold (Cohen et al., 1972).

Studies of the long-term effects of air pollution have observed an increase in the incidence of respiratory disease among children living in the more polluted areas. Douglas and Waller (1966) noted an increased incidence of bronchitis and colds in the chest among school children in areas with sulfur dioxide concentrations greater than 0.05 ppm annual average and suspended particulate levels greater than 132 ug/m^3 BS annual average.* In a study designed to observe possible health effects where sulfur dioxide exposures were very low, increased respiratory diseases (Hammer, 1977) and impaired lung functioning (Chapman et al. 1976) were observed among school children in a city with an annual average particulate level of approximately 130 ug/m^3 TSP compared to school children in a city with annual average particulate levels of approximately 75 ug/m^3 TSP.

Welfare

At high concentrations, certain types of particulate matter, especially very fine or chemically reactive particles, may damage plant surfaces or hinder biological functions of plants. Similarly, effects may be seen in animals and insects which inhale or ingest certain metals that have accumulated on food surfaces (Bromenshenk 1978).

*BS refers to particulate measurement by the British Smoke method; see pp. 53-54 of the draft EIS.

Measurement of Suspended Particulate Matter

Numerous devices exist to measure the concentration of particles in the air. The high volume sampler (hi-vol) collects all particles less than 100 micrometers although particles greater than 40 to 60 micrometers are collected with less efficiency than particles of smaller size. The actual upper limit varies with wind speed and direction. Because the mass of a large particle is so much greater than the mass of a small particle, one large particle influences the reported concentration the same as a substantial number of smaller particles. Thus information about the smaller particles will be obscured in data that are dominated by large particles. Several devices have been designed to separate the particles by size so that the concentration in each size class can be measured independently. Devices have been designed that count the particles individually and that collect the particles to be weighed. The Air Quality Bureau is presently using the dichotomous sampler, which divides the particles into a small and a large size group, but does not collect particles larger than 15 micrometers, which have much less effect on human health. The mass of particles collected on the two filters is measured to calculate the ambient concentrations.

Health effects researchers have used several different devices to measure the fine particle concentration in their studies. In general, comparative studies of these devices have not been conducted, so translations of these measurements into consistent terms could not be done with confidence. Thus it is not possible to express the fine particle concentrations where health effects would be observed as a concentration that would be measured by a single instrument, as for example, the dichotomous sampler. Without data applicable to a single instrument that could be selected as a measurement standard, it is not possible to define a health protective standard in terms of the fine particle concentration measured by a specific device.

Total suspended particulate is routinely measured by the high-volume method described in the draft EIS. This measuring technique has been prescribed by the U. S. Environmental Protection Agency for the measurement of particulate matter to determine compliance with the Federal standards. This method is currently being used by the Air Quality Bureau.

Selection of Ambient Air Quality Standard

Susceptible Populations

Children and persons with existing respiratory conditions are considered to be particularly sensitive to particulate pollution. The National Center for Health Statistics (1973) reports that in the western U. S. approximately 3 percent of the population experience continuing asthma, 1 percent has emphysema, and 3 percent are chronic bronchitis patients. Amont those over 65 years, approximately 4 percent have asthma, 3 percent emphysema, and 4 percent chronic bronchitis. Approximately 27 percent of the Montana population is under 14 years of age.

Level of Apparent Health Response

The Department has identified 300 ug/m^3 of total suspended particulate 24-hour average, as measured by the high-volume method, as likely to be associated with a decline in health and a reduced physical capacity for exercise among individuals with obstructive lung conditions and advanced heart disease, and an increase in the number of asthma attacks among persons with asthma. An annual average concentration of 130 ug/m^3 of total suspended particulate measured by the high-volume method is likely to be associated with an increased incidence of respiratory disease among children.

Uncertainty and Risk

Particulate matter air pollution presents a risk of permanent damage to the health of children and persons with existing asthma and chronic heary and lung disease. An increased incidence of asthma symptoms and asthma attack

increases the risk that an especially severe attack may be experienced. Such a severe attack can result in hospitalization and may result in long-term or permanent health damage.

Increased respiratory disease among children can have long-term as well as immediate adverse effects. Burrows et al. (1977) and others have observed that children with a history of respiratory disease are much more likely to develop chronic obstructive lung conditions as an adult. They also reported that adults with a history of childhood respiratory disease have a lower average lung function than individuals without a history of childhood respiratory disease.

Substantial uncertainty exists in the identification of a minimum concentration below which such human health effects do not occur. Several community studies or air pollution health effects have observed an association between these effects and sulfur dioxide and particulate pollution that increases steadily from the lowest pollution levels measured to the highest without any apparent threshold. Reported levels of minimum concentrations above which health effects are observed are often due to the study design rather than being any property of the pollutant.

Long-term studies of air pollution effects are difficult to interpret and the levels quoted may not be representative of the actual pollutant concentrations that precipitated the observed effect. Although a pollution level can be measured and associated with a geographic area where the effects are observed, the current health of the individual may be partly due to exposures in past years that may have been higher either because the pollution has been abated in the interim or the family has moved from a dirtier area. On the other hand, pollution levels may have been increasing as the economy and production have increased or the family may have lived in a cleaner area.

Synergistic Effects

Many epidemiological studies have compared the health of communities where the sulfur dioxide and particulate matter concentrations have both been high in one community and low in the other. From these studies it is not possible to state that the effects are due to either pollutant exclusively or that the effects are more than additive when both pollutants occur in sufficient concentrations in the same place.

Attempts to demonstrate the synergistic effect with laboratory animals often have involved tests at high concentrations of sulfur dioxide and particulates (Asmundson *et al*. 1973). Amdur (1978) has reported a synergistic response between sulfur dioxide and copper sulfate particles at moderate concentrations but no synergism for other sulfate particulates. The mechanism of the synergistic effect in studies such as this is not known nor is it clear that a synergistic effect exists at low concentrations. The synergistic effects, if any, can be accounted for by including epidemiological studies where both sulfur dioxide and particulate matter were present in the basis for the standard.

Recommended Standard

24-Hour Standard

The health responses observed from 24-hour exposures to 300 ug/m^3 of suspended particulate may result in permanent damage to the health of susceptible populations. The Department concedes a substantial degree of uncertainty in the identification of a concentration of particulate matter that will not present any risk to public health and safety. Several studies described here or in the draft EIS observed such effects when sulfur dioxide concentrations also were elevated. It is not known if the effects observed were simply the sum of the effects due to sulfur dioxide and particulates or were an increased,

synergistic effect. Other studies observed similar effects at concentrations less than 300 ug/m^3 but with less statistical certainty and with no apparent lower threshold where no effect could be observed. The high volume sampling technique used to evaluate compliance with this standard will measure varying amounts of fine particles that can enter the human airways and large particles that will be of much less health significance. The relative fraction of the total mass which is fine particles is not constant. This increases the uncertainty of the amount of respirable particulate that will be in the ambient air without exceeding the standards. Therefore, the Department recommends a standard of 200 ug/m^3, averaged over 24-hours, not to be exceeded more than once a year, measured by the high volume method.

The current Montana twenty-four hour standard is 200 ug/m^3, not to be exceeded more than three days a year. Although an exact equivalence cannot be stated, the present state standard might permit a twenty-four hour average exposure between 215 and 240 ug/m^3, not to be exceeded more than once a year, at many monitoring locations in the state. The current Federal primary standard is 260 ug/m^3, not to be exceeded more than once a year, and the secondary standard is 150 ug/m^3, not to be exceeded more than once a year.

Federal law requires that the primary standard be achieved throughout the state by December 31, 1982, subject to substantial penalties. The secondary standard is to be achieved "as expeditiously as possible" but no deadline is established nor are any penalties provided. As long as a region of the state has not demonstrated attainment of the secondary standard certain conditions are imposed on the construction of new sources of air pollutants or the modification of existing sources. Several agencies, including the Montana Air Quality Bureau, are now conducting studies of the health effects associated with particulate matter using measuring instruments that collect only respirable particles.

It is expected that sufficient data will be available to establish a standard based on such size-specific studies within the next 5 years. This is approximately the same time period over which enforcement of the federal secondary standards by the U. S. Environmental Protection Agency could be expected to begin. Therefore, adopting a single state standard which is less stringent than the federal secondary standard is not expected to be without reason. It will provide a meaningful, enforceable standard for the state and a useful tool in achieving air quality that will protect the public health and safety during this interim period.

An averaging time of twenty-four hours is consistent with the time periods reported in the community epidemiological studies cited above and is consistent with the averaging times of the Federal standards. An exceedance level of once per year, which is essentially a prohibition on concentrations above that amount, has been selected to be consistent with other air quality standards being proposed by the Department.

Annual Standard

Increased rates of respiratory infection have been observed in children in studies in communities where suspended particulate concentrations of 130 ug/m^3 and above. In several studies, sulfur dioxide concentrations also were elevated in these communities. The relative importance of sulfur dioxide in increasing the effects observed is not known, nor is it clear if a synergistic effect exists at low concentrations. In one study cited here, the sulfur dioxide concentrations were quite low. The Department recognizes the substantial uncertainty in both the measurement methods for suspended particulate matter and the apparent lack of any threshold for the observed effects. The Department is not able to identify the long-term concentration of pollutants that will not adversely affect public health and safety. Because of this substantial

uncertainty, the Department recommends an annual average standard of 75 ug/m^3 measured by the high volume method.

The current Montana annual average standard is 75 ug/m^3. The current Federal primary standard also is 75 ug/m^3 and the secondary standard is 60 ug/m^3. When the secondary standard was adopted, the Environmental Protection Agency specified that it was to be used only as an aid in evaluating the implementation plans submitted by the states.

Both the existing state standard and the Federal standards are expressed as the geometric mean of the year's observed daily average values. The proposed state standard is expressed as an arithmetic mean of the daily average values. An exact equivalence cannot be stated, but the existing state and Federal standards would be between 78 and 93 ug/m^3 if expressed as an arithmetic average at many monitoring locations in the state. While there are some mathematical conveniences in the use of the geometric average it is not a concept the average citizen is familiar with. Conversely the calculation of an arithmetic average is simpler and is familiar to everyone. By using the arithmetic average for suspended particulate, the annual average standard will be consistent with the standards for other pollutants recommended by the Department.

Consideration of Welfare Effects

The Department has carefully considered the practicality of more stringent standards in order to further protect the public welfare. No immediate effects on vegetation have been observed at the concentrations suggested as health protective standards. Effects on visibility and the nuisance of dustfall will be adequately prevented through other standards specific to those problems. The long-term effects of suspended particulate on climate and solar radiation are so poorly understood at this time that they cannot make any contribution to establishing a more stringent standard to protect the public welfare. There-

fore, the Department does not recommend any modification of the proposed standards for these purposes.

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The Department has reviewed the literature on the effects of particulate matter on the public health and welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 49-112 and pp. 183-188.

General Findings

If a particle 30 micrometers in diameter with the same density as water is emitted from a stack at an effective height of 65 feet, it will fall to the ground within 15 minutes, unless there is unusual vertical turbulance in the air. A particle of 20 micrometers diameter will reach the ground in less than 30 minutes from the same height. By contrast, a particle of one micrometer would require almost a week to fall that distance. Thus, it is mainly the larger particles, and especially those larger than 20 micrometers that settle to the ground near a source.

Human Health

In normal breathing patterns almost all particles greater than 20 micrometers will be stopped in the nose. In mouth breathing some large particles may enter the throat. Heavy exercise and rapid, deep breathing through the mouth may result in some large particles reaching the upper windpipe. With the exception of naturally occurring pollens and airborne bacteria, particles of this size are expected to have very little effects on human health.

Welfare

If sufficient quantities of these large particles settle on plant leaves the growth of the plant will be slowed and, over the long-term, the species composition of both forest (Brandt and Rhodes 1972) and grassland (Kovar 1977) vegetation communities will be significantly altered. Large

particles settling on surfaces also may be a nuisance requiring more frequent cleaning or creating dissatisfaction with the appearance of the surfaces. In an extensive interview study of residents of Birmingham, Alabama, (Stalker and Robison 1967) found that one-third of the residents expressed an annoyance with air pollution when the settled particulate exceeded 10 grams/square meter per month.

Measurement of Settled Particulate Matter

Settled particulate is routinely measured by the dustfall jar method described in the draft EIS. This method is currently being used by the Air Quality Bureau.

Selection of Ambient Air Quality Standard

Human Health Effects

The large particles which make up the mass of settled particulate matter have not been associated with adverse effects on human health.

Welfare Effects

Public annoyance has been recorded in response to dustfall. Adoption of a standard for settled particulate would reduce the inconvenience associated with significant levels of large particles.

Recommended Standard

After careful consideration of the studies cited here regarding the fallout of large particulate, the Department recommends that settled particulate should not exceed 10 gms/square meter, averaged over thirty days, to protect the public welfare.

The current Montana standard for settled particulate is 15 tons per square mile per month, averaged over three months, in residential areas

and 30 tons per square mile per month, averaged over three months, in heavy industrial areas. This is equivalent to a standard of 5.3 g/m^2/month in residential areas and 10.5 g/m^2/month in heavy industrial areas. The use of a consecutive thirty day averaging period rather than a three-month average would result in the application of the proposed standard being slightly more stringent than the existing rule for heavy industrial areas. There is no federal standard for settled particulate matter.

Consideration of Practicability

Settled particulate consists primarily of larger particles such as silt, fine sand, and pulverized rock from earth moving operations, flyash from open fires and uncontrolled stoves and burners, cement dusts, and milled flour. Removal of particles of this size from an exhaust gas stream is easily and inexpensively accomplished by a settling chamber or cyclone collector. Such control devices often would be used simply to protect fans and other equipment from excessive wear caused by these particles. Control or particulate emissions from earth moving operations is more difficult. Watering or even paving of roadways and parking areas and watering of working areas often is used to hold down dust emissions. When there is very little natural moisture in the soil the requirements for watering can be extensive and costly.

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The Department reviewed the literature on the effects of lead on public health and welfare. The principal features of that literature were described in the draft EIS at pp. 113-130.

General Findings

Human Health

Lead accumulates in humans from a variety of environmental sources. The human body acquires lead from water supplies, the soil, canned or fresh food, peeling paint, and from lead contaminated air.

Accumulation of lead in the bones is a sign of long-term cumulative exposures while elevated lead levels in the blood and soft tissues such as the liver and kidneys arises from shorter more recent exposure.

Lead's effects on blood formation and the nervous system are the most important adverse effects from an air quality standpoint. An increase in anemia symptoms has been found in adults as blood lead levels rise toward 50 micrograms of lead per deciliter of blood (50 ug/dl) Tola et al. 1973). The threshold level for such effects is slightly lower in children, witn anemia symptoms observed to increase as blood lead levels rise above 40 ug/dl (Pueschel et al. 1974).

Lead induced anemia results from the disruption of two important steps in the formation of hemoglobin. Excessive blood lead blocks the activity of the enzyme ALAD, which helps assemble components of the hemoglobin molecule, and it inhibits the insertion of iron into hemoglobin, a blood component necessary for oxygen transport. When the iron insertion step is interrupted a compound known as erythrocyte protoporphyrin (EP) is formed. The presence of EP in the blood is a direct indicator of interference with hemoglobin formation and is

considered along with elevated blood lead levels to signify an increased risk of anemia.

Various researchers have measured the blood lead level capable of causing reductions in ALAD. Granick et al. (1973) found that a blood level as low as 17 ug/dl can cause a detectable reduction in ALAD activity. Hernberg and Nikkanen, (1970) noted that 55 ug/dl blood lead inactivated 90 percent of blood's ALAD component.

The threshold for elevated EP in children has been found to be between 15 and 20 ug/dl blood lead. The Center for Disease Control of the U.S. Public Health Service (1978) says a blood lead level of 30 ug/dl or lower with EP levels of 109 ug/dl is required for the prevention of anemia symptoms in children.

The effects of lead exposure on the human nervous system ranges from irrepairable brain damage to subtle changes in nerve functioning and reduced scores on intelligence tests. Irreversible brain damage occurs in adults above 120 ug/dl and in children at levels as low as 80 ug/dl (Kehoe, 1961; Bradley et al. 1956: Bradley and Baumgartner, 1958).

Impaired mental abilities occur in children even at low blood lead levels. Perino and Ernhart (1974) noted that preschool children with blood lead levels of 40 to 70 ug/dl performed significantly poorer on standard intelligence tests than children with blood lead levels between 10 and 30 ug/dl. Landrigan et al. (1975) found that children with 40 ug/dl blood lead tested less well than those with low blood lead levels. Recently, Needleman et al. (1978) found that children with 35 ug/dl blood lead had significantly poorer mental performance than children with 24 ug/dl. In most tests of childrens' mental skills, blood lead levels were below the level at which overt signs of anemia were evident.

The relationship between the concentration of lead in the air and blood lead levels has been determined by several researchers. Azar et al. (1975) determined this relationship in healthy adults. The Azar et al. study indicates that 0.1, 0.3, and 0.5 percent of the adult population will be expected to exceed 40 ug/dl blood level at 1.0, 2.0 and 3.0 ug/m^3 air lead levels respectively. This work found that small increases in low air lead concentrations raised blood lead levels more than equal increases at higher air lead concentrations. Yankel et al. (1977) attempted a similar analysis of the blood lead-air lead relationship in children near a lead smelter in Idaho. They found that a greater percentage of the children living in areas of high soil lead exceeded a given blood lead level than those residing in areas of low soil lead when both were exposes to the same air lead concentration. Their work emphasizes the need to consider soil lead levels when establishing an ambient air quality standard for lead. The Yankel et al. study predicted that at air lead concentrations of 2.0 ug/m^3, 12 percent of the children exposed to 5000 ug/g soil lead would be expected to exceed 40 ug/dl, compared to the three precent of the children who would exceed that level when living in areas with 500 ug/g soil lead.

The two major lead emitting industries in Montana are the Anaconda Copper smelter at Anaconda and the ASARCO smelting complex at East Helena. A study sponsored by the Environmental Protection Agency in 1969 found lead contaminated soils from 4000 to 100 ug/g at varying distances from the ASARCO smelter (Meisch and Huffman, 1972). Air lead levels during the course of the study averaged 3.9 ug/m^3 in East Helena, as compared to an average of 0.1 ug/m^3 in Helena (Huey, 1972). Blood lead levels were higher in ten year old children in East Helena than in Helena children of the same age (Hammer et al. 1972). Another blood lead study conducted in East Helena in 1975 found that 23 percent of children between the ages of 18 months and 10 years had blood lead

levels above 30 ug/dl with seven percent exceeding 40 ug/dl (Eden, 1975). A test of Anaconda children in 1975 indicated that 36 percent of those tested had blood lead levels exceeding 30 ug/dl (Jankowski, 1975).

Welfare

Lead poisoning of animals has been recorded near smelters, mines, and industrial plants (Schmitt et al. 1971). Hammond and Aronson (1964) estimated the minimum cumulative dose for lead poisoning in cattle to be between six and seven mg/kg body weight per day. Hammond et al. (1972) estimates a lower tolerance in horses, between 1.7 and 2.4 mg/kg body weight per day. Horses are susceptible to lead poisoning not only because of their lower tolerance to lead but also because of their close cropping feeding habits which result in the consumption of lead contaminated soil.

Cattle and horses are reported to have died from consuming excessive lead on plants and in soil near the ASARCO lead smelter in East Helena (Lewis, 1972; Hubble, 1978).

Vegetation appears to be protected from airborne lead by the inability of lead particles to enter the plants and affect internal plant processes (Carlson et al. 1976). Plants can, however, be damaged by excessive lead in the soil in which they are grown. The degree of soil lead toxicity to plants depends in part on the chemical and physical properties of the soil (Zimdahl, 1976).

Measurement of Airborne Lead

Lead will be measured by the atomic absorption method required by the EPA to ensure compliance with Federal Standards. This method determines the quantity of lead in suspended particulate matter collected over 24 hours on a high volume

air sampler using fiberglass filter media. It is accurate and reliable within the expected range of ambient concentrations experienced in Montana.

Selection of An Ambient Air Quality Standard

Susceptible Populations

Children (age one to five), are considered highly susceptible to adverse health effects from excessive lead exposure.

Children's susceptibility to lead poisoning results from their higher metabolic rate, reduced margin of safety against stress, and incomplete development of certain metabolic processes and the blood-brain barrier. Certain behavioral traits in children such as their tendency to put nonfood substances in their mouths make them more likely to ingest lead contaminants.

Level of Apparent Health Response

The level of blood lead necessary to cause an increase in the incidence of anemia in healthy adult populations is 50 ug/dl. Children have consistently been shown to manifest a variety of adverse health responses at blood lead levels lower than those affecting adult populations. An increase in anemia symptoms and a decline in mental abilities have been associated with blood lead levels between 35 and 45 ug/dl in children. Changes in certain blood forming processes begin to be altered above 15 to 20 ug/dl.

Uncertainty and Risk

As blood lead levels rise above 35 to 40 ug/dl, the risk of intelligence impairment and the risk of blood disorders increase in children. If diagnosed and treated soon after they become apparent, clinical symtoms of anemia can be reversed. It is not entirely clear whether reductions in mental capabilities can be fully restored by medical treatment. Moreover, because a reduction in

mental capabilities often goes undiagnosed, the risk posed by continued toxicity is heightened and the chance of irreversible losses is increased.

It has been shown that as air lead concentrations increase the risk of elevated blood lead levels also increases. Air lead-blood lead relationships also are influenced by the amount of soil lead present. Risk of high blood lead levels occurs in children simultaneously exposed to high soil and air lead because of their tendency to ingest contaminated material.

The extent of risk that a child will experience a health response to a given air lead concentration is a function of three probabilities: (1) that certain air and soil lead levels will occur together, (2) that air and soil lead levels occurring together will cause an elevated blood lead level, (3) that an elevated blood lead level will cause a health related response. The proposed ambient air quality standard for lead is based on a consideration of the risk from these probabilities.

There is some indication that other segments of the population may be even more sensitive to lead than children. Pregnant women appear vulnerable to the effects of lead because of the physical stress and nutritional demands of pregnancy. The unborn are endangered because their nervous systems are only partially developed and because of the ease with which lead can cross the placental barrier between mother and fetus.

Recommended Standard

The Department recommends an ambient air quality standard for lead of 1.5 ug/m^3, 90 day average, not to be exceeded, to protect the public health.

The proposed standard is based on the necessity of keeping nearly all Montana children below 40 ug/dl blood lead. At this level, children begin to have an increasing chance of developing several health related responses.

Important considerations in establishing the proposed standard were the contribution of soil lead levels to increased blood lead levels in children and the elevated concentrations of lead in some East Helena soils.

Based upon a model developed in an environmental setting similar to East Helena, the proposed standard would be expected to protect 92 to 95 percent of East Helena Children living in the city's higher soil lead areas from incurring blood levels above 40 ug/dl. The standard would protect a far higher percentage of children in areas where soil lead was lower than in East Helena.

It is believed the proposed air quality standard for lead would reduce the probability of excessive blood lead concentrations and therefore reduce the probability of health related respones to the point where there is no longer a statistically significant threat the public health and safety.

The current Montana rule for lead is 5.0 ug/m^3, 30 day average. This is roughly equivalent to a 3.5 to 4.0 ug/m^3 90 day average. The proposed lead standard is approximately 2.3 to 2.7 times more stringent than the existing standard. The federal standard for lead is 1.5 ug/m^3, calendar quarter average. This standard is slightly less stringent than Montana's proposal. There are potentially 60 violations possible per year if measurements are taken every sixth day under the state standard while under the federal standard only four opportunities for violations are possible in one year.

Consideration of Welfare Effects

The effects of lead on the public welfare have been considered, and do not appear to require a more stringent air quality standard to ensure their protection. Vegetation is resistant to the toxicity of ambient lead and would be protected under the proposed standard. The accumulation of lead in domestic and wild animals is more directly related to ingestion of contaminated soil

and vegetation than from inhalation of excessive ambient air lead. Under the proposed ambient lead standard, some elevation of lead levels in soil and vegetation is inevitable. It is not possible to determine whether such levels pose a threat to grazing animals until further information becomes available.

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CARBON MONOXIDE

The Department reviewed the literature on the effects of carbon monoxide on the public health and welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 131-146.

General Findings

Human Health

Carbon monoxide is absorbed into the blood through the lungs, forming carboxyhemoglobin, which interferes with the ability of the blood to transport and to release oxygen to the tissues. There is a definite correlation between a given concentration of carboxyhemoglobin in the blood and concentrations of carbon monoxide in the air, the duration of the exposure, and the level of physical activity during the exposure. An equation developed by Coburn, et al. (1965) accurately relates these factors. The effects of carbon monoxide have been shown to be directly related to the concentration of carboxyhemoglobin in the blood.

Severe damage to the heart and nervous system and eventual death is observed in animals when 75 percent of the blood hemoglobin is replaced by carboxyhemoglobin (Drabkin et al., 1943). This is assumed to be the approximate level at which death occurs in humans from carbon monoxide poisoning. The effects of carbon monoxide on general human populations are first observed at concentrations of 4 to 5 percent blood carboxyhemoglobin. At these concentrations the ability to perform simple mental tasks is adversely affected (Halperin et al. 1959; Schulte, 1963; Horvath et al., 1971) and the ability to perform physical exercise or work is decreased. Decreased tolerance for exercise has been observed at 3 percent blood carboxyhemoglobin in persons with heart disease, lung disease, or certain diseases of the blood vessels (Anderson et al., 1973; Aronow and Isbell, 1973; Aronow et al., 1974; Aronow et al., 1977).

Welfare

The effects of carbon monoxide on livestock and other animals may be expected to parallel human health effects. Carbon monoxide has not been associated with effects upon vegetation or the environment except at much stronger concentrations than those known to harm human health.

Measurement of Carbon Monoxide

Carbon monoxide is routinely measured by the nondispersive infra-red method described in the draft EIS. This measuring technique has been prescribed by the U. S. Environmental Protection Agency for the measurement of carbon monoxide to determine compliance with the federal standards. It is accurate and reliable within the expected range of ambient concentrations.

Selection of Ambient Air Quality Standard

Susceptible Population

Persons with an impaired heart, lungs or blood vessels are particularly sensitive to the effects of carbon monoxide. It presents them with a compound problem. First, their ability to tolerate exercise is reduced. Second carbon monoxide may, as indicated by studies with animals, cause structural changes in heart tissues that may lead to heart disease (Thomsen and Kjeldsen, 1974). Third, it may delay the recovery from heart attacks (DeBias, et al., 1978).

The size of the susceptible population may be large. An autopsy study found that almost 80 percent of the young men studied had evidence of incipient coronary artery disease (Eros et al., 1953). Epstein (1973) estimates that about ten percent of middle-aged men will experience a "heart attack" and another five percent will develop angina pectoris. The National Center for Health Statistics (1973) reports that in the western U.S. about 7 percent of the total population and about 11 percent of the population over 65 experiences

chronically impaired lung function.

Pregnant women (more specifically their fetuses) also are particularly vulnerable to carbon monoxide. Elevated carboxyhemoglobin levels in pregnant women have been shown to correspond to lower birth weights. Very little data is available on the longer term effects on the children or the specific levels of carboxyhemoglobin causing the effect (Astrup et al., 1972).

Level of Apparent Health Response

Based on the studies cited here, the Department has identified three to five percent blood carboxyhemoglobin as likely to be associated with decreased physical capacity for exercise and increased errors in mental activity in general and sensitive populations.

Uncertainty and Risk

The accumulation of carbon monoxide in the blood is reversible with exposure to clean air. If no adverse event occurs during the period of elevated blood carboxyhemoglobin the effects of a short-term exposure appear to be temporary and without consequence. Chronic exposures may have long-term adverse consequences, possibly contributing to heart disease in the general public or unknown effects on the unborn.

The most likely adverse effect on the general population from carboxyhemoglobin levels of three to five percent is a reduced tolerance for work or exercise. Persons with impaired heart or lungs may also experience pain or shortness of breath. Less likely but possible in either normal or impaired persons is a sudden heart attack which could result in death. Among the vulnerable populations the risks of death due to a heart attack are increased since the ability of the heart to respond to stress is already reduced.

A significant number of studies of short-term effects have produced roughly similar results indicating clear evidence of effects at three percent

blood carboxyhemoglobin, although some individuals in the study groups showed effects at lower concentrations. The lack of studies on long-term effects leaves some uncertainty in identifying a minimum level of blood carboxyhemoglobin below which effects will not occur.

Recommended Standard

Because of the uncertainty involved in identifying the concentrations of blood carboxyhemoglobin low enough to have no effect on the public health or safety, and the nature of the health effects associated with concentrations in the range of three to five percent, the Department recommends adoption of an ambient air quality standard which will prevent blood concentrations of carboxyhemoglobin in excess of two percent, to assure protection of the public health.

As explained on pp. 132-4 of the draft EIS the amount of carbon monoxide absorbed in a given period of time depends on the level of physical activity and other physical characteristics.

In determining a safe level for the one-hour standard, the Department concluded it was necessary to protect persons who might be exercising during that hour, and therefore more than usually susceptible to carbon monoxide. For the eight-hour standard, the safe level was calculated with the assumption that the exposed population would be at rest during most of the exposure period. As noted on page 108 of this final EIS, an adult woman at rest at 3000 feet elevation exposed to 12 ppm for a period of eight hours will attain a blood carboxyhemoglobin level of two percent. Similarly, if she is exercising or working for one hour, an exposure to 23 ppm will result in a blood carboxyhemoglobin level of two percent.

At present there is no state regulation for carbon monoxide in Montana. Current federal regulations require the state to achieve a standard of not more than 9 ppm, for eight hour exposures and 35 ppm for one-hour exposures.

A reference to page 108 of this final EIS will show that an adult woman at rest at 3000 feet elevation exposed to 9 ppm for eight hours would attain a blood carboxyhemoglobin level of 1.5 percent and exposure during exercise to 35 ppm for one hour would result in a blood carboxyhemoglobin concentration of 3 percent. At 3 percent, vulnerable individuals (including members of the general population with undiagnosed heart disease) will experience an increased risk of adverse events.

Given the requirements of the Federal Clean Air Act, the Department believes that it would be pointless to adopt a standard less stringent than the current federal primary standard. Therefore the Department is recommending a standard of 9 ppm for eight-hour averaging periods. Conversely, the federal one-hour standard was set under the assumption that the subject individual was an adult male at rest at sea level. The Department believes the assumptions outlined above are more responsive to the requirement that the standard protect the public health and safety, and so recommends a standard of 23 ppm, for one-hour averaging periods.

The medical evidence for the standard is entirely based on concentrations of blood carboxyhemoglobin and is not related to any particular averaging time. The selection of an averaging time is entirely a matter of insuring that the measured and regulated atmospheric concentrations will not result in that carboxyhemoglobin levels above two percent in a person continuously exposed to that ambient concentration. Averaging times of one hour and eight hours have been selected to maintain consistency with the federal standards. Similarly, an exceedance level of once per year, which is essentially a prohibition on concentrations above that amount, has been selected to be consistent with other air quality standards recommended by the Department.

Consideration of Welfare Effects

The Department has carefully considered the practicality of a more stringent standard in order to further protect the public welfare. No immediate effects on vegetation have been observed at the concentrations suggested as a health protective standard. Long-term effects on the ecosystem through the production of ozone or carbon dioxide are so poorly understood that they cannot contribute to establishing a more stringent standard to protect the public welfare. Therefore, the Department does not recommend any modification of the proposed standards for these purposes.

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NITROGEN DIOXIDE

The Department reviewed the literature on the effects of nitrogen dioxide on the public health and welfare. The principal features of the literature were described in the draft Environmental Impact Statement at pp. 147-159 and pp. 260-263.

General Findings

Human Health

Nitrogen dioxide has many of the same biological effects as ozone; it is known to reduce lung function and injure the body's antibacterial mechanisms increasing susceptibility to lung infection.

Animal studies have shown that nitrogen dioxide causes cell death and alterations of tissue structure in the lung. One study found reductions in chemicals associated with blood flow in mice lungs after a three hour exposure to 0.2 ppm nitrogen dioxide. No further reductions in these chemicals were noted at 2.0 and 19 ppm but a longer recovery period was necessary after exposure to the higher doses (Menzel, 1978). Mice exposed to 0.5 ppm for 12 months show the same lung tissue changes that occur at higher concentrations for the same exposure period (Blair et al. 1969). This observation suggests that the concentration of nitrogen dioxide is more important than time of exposure in causing response.

Studies have shown that the susceptibility of some animal species to airborne infection is increased by exposure to nitrogen dioxide. Coffin et al. (1976) and Ehrlich and Henry (1968) found that continuous or intermittent exposures of laboratory animals to nitrogen dioxide at 0.5 ppm or more increased the death rate of laboratory animals exposed to infectious bacteria.

Experimental exposures of humans with chronic bronchitis to concentrations

of 1.5 ppm nitrogen dioxide for 15 minutes produced a detectable increase in airway resistance (von Nieding and Krekeler 1971). At levels above 5.0 ppm, subjects with no respiratory ailments exhibited diminished diffusing capacity of the lungs (von Nieding et al. 1973).

Nitrogen dioxide has been shown to increase the severity of asthma attacks. An experiment conducted by Orehek et al. (1976) found that 0.11 ppm nitrogen dioxide for one hour caused a significant increase in lung resistance in three of 20 subjects. However, when the same nitrogen dioxide exposure was combined with a bronchoconstricting agent (carbachol), 13 out of the 20 showed an increased lung sensitivity to the drug. The dosage of carbachol necessary to produce a two fold increase in lung resistance was decreased from 0.66 mg under control conditions to 0.36 mg under conditions of nitrogen dioxide exposure. These results indicate that although nitrogen dioxide cannot itself induce an asthma attack under normal circumstances, it can increase the vulnerability of persons who are already on the verge of an attack.

Studies suggest that multiple short-term exposures to nitrogen dioxide cause increased lower respiratory illnesses in children. A significantly greater number of coughs, colds going to the chest, and bronchitis were found in English children living in homes with gas stoves than in homes with electric stoves (Melia et al. 1977). Because gas stoves are a known source of nitrogen dioxide, the effects noted in the Melia study were attributed to elevated nitrogen dioxide levels. A subsequent study, Melia et al. (1978) compared the nitrogen dioxide levels in gas stove homes with concentrations in homes with electric stoves. Their results showed that gas kitchens had a four day average nitrogen dioxide level of

0.07 ppm while homes with electric kitchens recorded levels of 0.01 ppm. Similarly, Palmes (1977) found average nitrogen dioxide levels of 0.05 ppm in U.S. homes with gas ranges and 0.01 ppm in homes with electric stoves. Wade et al. (1975) measured a maximum two hour average nitrogen dioxide level between 0.1 and 0.3 ppm near gas stoves in several U.S. households.

Long-term averages of nitrogen dioxide have been implicated as significant in causing respiratory diseases in children. Near Chattanooga, Tennesses, studies were conducted that associated annual nitrogen dioxide levels of 0.08 to 0.15 ppm with increased respiratory disease and breathing difficulties in children (Shy et al. 1970a, 1970b). Increases in lung disease (chronic bronchitis) also were noted in elementary school children and infants at these exposures (Pearlman, 1971).

Plants and Animals

Nitrogen dioxide is toxic to vegetation. Scientific evidence indicates that the concentrations necessary to cause visible injury and growth and yield losses in Montana vegetation are 1.0 to 3.5 ppm for 24-48 hours and 0.25 ppm over a growing season.

Nitrogen dioxide combined with other pollutants has been experimentally shown to cause greater than additive injury to vegetation (synergistic effects). Pollutants known to act synergistically with nitrogen dioxide are sulfur dioxide, ozone, and fluoride. It is not known what combined levels of these pollutants would be required to damage Montana vegetation.

The impacts of nitrogen dioxide on livestock and wildlife are not known, but effects similar to those found in experimental animals are thought to be likely.

Nitrogen dioxide also has been implicated as an agent in the production of acid rain. Little definitive work has been conducted on the subject.

Measurement of Nitrogen Dioxide

Nitrogen dioxide is routinely measured by the chemiluminescence method described in the draft EIS. This measuring technique has been prescribed by the EPA for the measurement of nitrogen dioxide to determine compliance with the federal annual standard. It is accurate and reliable within the expected range of ambient concentrations expected in Montana.

Selection of Ambient Air Quality Standards

Susceptible Population

Controlled human exposure tests and epidemiological studies indicate that children and persons who suffer from asthma are most susceptible to nitrogen dioxide. Individuals with chronic lung disease and the elderly are probably susceptible also.

Level of Apparent Health Response

Based on the studies cited above the Department has determined that multiple short-term exposures at 0.1 to 0.3 ppm and long-term exposures at 0.07 to 0.15 ppm nitrogen dioxide are likely to be associated with an increased incidence of respiratory illness in children.

Uncertainty and Risk

Analysis of animal studies leads to the conclusion that intermittent or continuous exposure to 0.5 ppm nitrogen dioxide results in lung tissue

alterations, increased death rate from greater susceptibility to bacterial infection, and changes in lung function and the immunological system. The bacterial infectivity studies on animals are thought to indicate that similar effects probably occur in humans. Because the breathing pattern of these laboratory animals is much more shallow than the breathing pattern of humans, the effect in humans may occur at lower concentrations. Medical ethics preclude the use of humans as subjects in bacterial infection experiments and as a result no such tests have been conducted to determine what level of nitrogen dioxide is capable of causing similar effects in humans. Nonetheless, the Department believes the infectivity model showing serious health effects in animal studies is applicable to humans and should be considered when setting a nitrogen dioxide standard to protect human health.

People with asthma are sensitive to nitrogen dioxide. This sensitivity is particularly apparent when the early stages of an attack coincides with exposure to nitrogen dioxide. The seriousness and risk to persons with asthma is related to the percentage of time nitrogen dioxide levels are above 0.1 ppm. The longer nitrogen dioxide levels remain above 0.1 ppm, the greater is the likelihood sensitive persons will experience a greater rate of asthma attacks or that an attack when it occurs will be more serious, and more dangerous to health.

The Department believes that increased respiratory disease has long-term health consequences. Several researchers have observed that a history of respiratory disease as a child is associated with reduced lung function and an increased risk of chronic obstructive lung disease in adults.

Recommended Standard

One-Hour Standard

The results from animal studies indicate the need for a short term standard for nitrogen dioxide. The Department therefore proposes a 0.30 ppm one-hour standard for nitrogen dioxide, not to be exceeded more than once a year, to protect the public health.

Air pollution concentrations generally follow a predictable pattern of frequency with time. Analysis of these patterns indicates that a one hour standard of 0.30 ppm with one exceedance allowed annually would protect the general public from an excessive number of short-term exposures in the range of 0.1 to 0.2 ppm. There is no Montana or federal one-hour standard for nitrogen dioxide.

Annual Standard

The Chattanooga epidemiological studies and indoor air pollution studies of homes using gas stoves observed clinically diagnosed illnesses in children with long-term exposure to concentrations ranging from 0.07 to 0.15 ppm. These effects are clinically diagnosed illness, rather than a response threshold. The Department concluded that there was a need for a 0.05 ppm annual average nitrogen dioxide standard to protect the public health. This standard would protect against nitrogen dioxide levels shown to cause health related responses in sensitive persons. The proposed Montana standard is the same as the federal annual average standard for nitrogen dioxide. There is no current annual nitrogen dioxide rule in Montana.

Consideration of Welfare Effects

The Department considered the possibility that more stringent nitrogen dioxide standards were needed to protect the public welfare. While nitrogen dioxide can damage vegetation, the proposed standards are expected to keep levels below those capable of damaging Montana plants. There are not enough data to indicate what standard would be needed to prevent formation of acid rain from nitrogen dioxide. Further research is needed to define the effect of various nitrogen dioxide concentrations on acid rain formation.

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The Department has reviewed the literature on the effects of ozone on public health and welfare. The principal results of that literature were described in the draft EIS at pp. 160-182.

General Findings

The term "photochemical oxidants" comprises a group of gases formed from the interaction of sunlight and certain pollutants (primarily hydrocarbons) in the air. The most common pollutant in this group is ozone (O_3). Other important photochemical oxidants are hydrogen peroxide (H_2O_2), aldehydes (especially formaldehyde), acrolein, formic acid, and peroxyacetlynitrate (PAN). Control of photochemical oxidant pollution is accomplished through an ambient standard for ozone.

Human Health

Ozone is a pulmonary irritant affecting the lung's structure, gas exchange functions and defenses against bacteria. Changes in lung function caused by ozone often are accompanied by clinical symptoms such as coughing, chest tightness, and lower chest soreness. These effects are most pronounced in persons engaged in strenuous exercise and those with a history of asthma.

Clinical studies investigating the effects of ozone on lung function in healthy exercising subjects show that a two-hour exposure to 0.37 to 0.75 ppm ozone causes a significant decrease in lung function (Hazucha *et al*. 1973, Bates and Hazucha, 1973; Hackney *et al*. 1975).

Research conducted by Von Neiding *et al*. (1976) suggests but does not confirm that detrimental lung changes occur in healthy individuals after a two hour exposure to 0.10 to 0.25 ppm ozone. More recently, Delucia and Adams (1977) found that subjective symptoms of discomfort occurred in indivi-

duals breathing 0.15 ppm ozone for one hour during vigorous exercise. At 0.30 ppm ozone for one hour with vigorous exercise these same subjects had statistically significant lung function changes and discomfort similar to that noted at 0.15 ppm.

The adverse effects of the ozone-oxidant complex on individuals with asthma have been associated with daily maximum oxidant levels above 0.25 ppm. Schoettlin and Landau (1961) found that the average number of asthma patients having attacks was statistically greater on days when oxidant levels exceeded 0.25 ppm than on days when the maximum hourly average was below this level.

Short-term oxidant exposures also have been associated with increased illness and decreases in athletic performance. In a study of Los Angeles student nurses, Hammer _et al_. (1974) found that eye irritation, coughs, and chest discomfort increased on days when the daily maximum hourly oxidant levels were above 0.20 ppm. Wayne _et al_. (1967) found that altered performance of cross-country runners was correlated with hourly oxidant levels between 0.10 and 0.30 ppm. The effects between a reduction in the performance of the runners and oxidant levels was best seen above 0.15 ppm.

Ozone has been shown to cause an increased rate of mortality in laboratory animals subjected to bacteria infection (Coffin _et al_. 1968; Miller _et al_. 1978). Although not directly applicable to humans, these results suggest a similar decreased resistance may occur in human populations exposed to ozone. The ozone concentration and exposure durations sufficient to cause these effects in humans are not known.

It has also been suggested that ozone acts synergistically with other air pollutants causing lung function changes. Hazucha and Bates (1975) found that subjects exposed for two hours to a mixture of 0.37 ppm ozone and 0.47 ppm sulfur dioxide experienced significantly greater changes in lung

function than would result from the sum of the separate effects of the individual pollutants. However, Bell et al. (1977) and Bedi et al. (1979) in similar experiments, observed that a two-hour exposure to both sulfur dioxide and ozone at 0.37 ppm and 0.40 ppm respectively had only a small interactive effect on lung function. Other simultaneous exposure tests using ozone mixed with nitrogen dioxide, and with a nitrogen dioxide-carbon monoxide mixture have produced few important lung function changes and only mild symptoms (Hackney et al. 1975).

Welfare

Vegetation damage from ozone and other oxidants has been observed in California since the 1940s (Middleton et al. 1950). Oxidant damage to vegetation has not been recorded in Montana but experimental studies on plants found in this state have determined the concentrations and exposure durations capable of causing damage. Table III.E-II on page 169 of the draft EIS summarizes these results. From this table it can be seen that cultivated plants can be visibly injured and their growth reduced by 0.05 to 0.15 ppm ozone for exposures of three to 68 days. Similiarly, native forest vegetation is damaged at levels between 0.15 and 0.30 ppm for exposure periods from 10 days to a full growing season. Ozone, in combination with other air pollutants, is known to cause synergistic effects in vegetation at various concentrations and over various exposures. The concentrations of pollutants capable of causing this effect vary with the pollutant mixture, plant species, exposure duration, and environmental conditions under which the exposure takes place.

The extent of ozone effects on domestic animals and wildlife is unknown. Concentrations capable of causing adverse effects are most likely similar to those found to affect laboratory animals.

Ozone and other photochemical pollutants accelerate the aging of many

materials. Economically useful materials known to degrade with exposure to ozone include rubber, textile dyes and fibers, and certain paint products. Rubber appears to be most sensitive to ozone.

Measurement of Ozone

Ozone is measured by the chemiluminescence method described in the draft EIS. This method is required by the U. S. Environmental Protection Agency for the determination of compliance with federal standards. It is accurate and reliable within the expected range of ambient concentrations experienced in Montana.

Selection of an Ambient Air Quality Standard

Susceptible Population

Clinical and epidemiological studies have shown that asthmatics and individuals with hyperreactive airways (wheezing in response to allergy or air pollution) have a lower than average tolerance to ozone. Healthy, actively exercising individuals will, at a given ambient ozone concentration, deliver an increased amount of ozone to their respiratory tract, making them more vulnerable to the effects of lower ozone concentrations than when they are sedentary or at rest.

Level of Apparent Health Response

The Department has identified one hour oxidant levels above 0.25 ppm as likely to be associated with the aggravation of chronic respiratory disease. The ozone portion of this oxidant level is estimated to be between 0.16 and 0.23 ppm, based upon known ratios of ozone and oxidants measured in urban areas.

Clinical and epidemiological studies indicate that at 0.15 ppm ozone subjective feelings of chest discomfort may be observed in vigorously exercising individuals. At 0.30 ppm, studies indicate that both lung function

reductions and discomfort are present at moderate exercise levels. The Department concludes that between 0.15 ppm and 0.20 ppm ozone health responses will occur in sensitive populations.

Uncertainty and Risk

Healthy individuals have a reserve lung capacity enabling them to tolerate substantial increases in airway resistance without noticeable effects. Individuals with a chronic respiratory disease may not have a reserve lung capacity even when not exercising. Thus any increase in airway resistance may aggravate pre-existing pulmonary disease.

The Department views with some concern the results from animal studies which show increased susceptibility to infection in laboratory animals exposed to both ozone and bacteria. Although the resulting increases in susceptibility to bacteria are known to exist in laboratory animals, no information is available on the concentrations and durations necessary to cause similar effects in humans.

It is uncertain what role ozone plays in combination with other pollutants to cause reductions in human lung functions. There also are questions raised by European experiments using measurement methods not commonly utilized in the United States that suggest reductions in certain lung function parameters occur in healthy subjects exposed to 0.10 ppm ozone for two hours.

Ozone production in the air requires an abundance of sunlight, relatively warm air temperatures, and a supply of reactive air pollutants, so certain areas of the country are more prone to high ozone levels than others. Montana's atmospheric conditions are less conducive to ozone production than more populated and warmer parts of the U.S. As a result, the potential risk for elevated ozone concentrations is substantially lower in Montana than elsewhere.

Recommended Standard

The Department recommends a one-hour ozone standard of 0.10 ppm, not to be exceeded more than once per year to protect the public health. This standard includes a margin of safety to protect against uncertainties indicated in recent scientific studies.

While it is true that the potential for ozone generation is not as great in Montana as in other states, the uncertainty and risk of effects occurring in sensitive populations below the known 0.15 to 0.20 ppm level of apparent health response concerns the Department. The recommended standard reflects these concerns, particularly those dealing with lung infection observed in laboratory animals subjected simultaneously to ozone and bacterial challenge, and the ozone response level in healthy exercising individuals. These studies raise questions concerning the risk of similar or more serious effects at even lower levels in sensitive members of the populations.

The present EPA standard is 0.12 ppm one hour average, not to be exceeded more than once per year. The EPA and Montana proposed standards are derived from a similar evaluation of the literature. While the EPA standard should protect most individuals from known health responses to ozone, little margin of safety is included. The Montana ozone standard would provide at least as much protection as the federal standard with increased stringency to deal with uncertainties in the literature.

Consideration of Welfare Effects

The Department has reviewed the literature on the level of ozone capable of causing damage to the public welfare. It has been determined that vegetation and the ecosystems they support are the environmental elements most susceptible to elevated ozone levels.

Under normal meteorological conditions, the proposed ozone standard ensures that the distribution of ozone would be low enough to protect vegetation

and ecosystems. It is not clear whether the proposed standard would ensure equal protection against ozone in combination with other air pollutants. Studies into the effects of combined pollutants are inconclusive, owing to questions about what levels of other air pollutants are needed, what plant species are susceptible, and many other questions. Until questions of this nature are resolved, these potential effects cannot be used as the basis of a more stringent standard.

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VISIBILITY

The Department reviewed the literature on the effects of visibility degradation on the public welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 183-188.

General Findings

The impairment of visibility is caused by gases and particles which scatter and absorb light (Middleton, 1952). Nitrogen dioxide is the only gaseous pollutant that absorbs visible light in significant amounts. This gas is found in sufficient concentration to affect visibility only in smokestack plumes or in a few urban areas (e.g., southern California). The gases that reduce visibility are naturally present in the air, and are not the result of pollution.

Thus, visibility degradation in Montana is caused almost entirely by airborne particles. These particles may either scatter or absorb light. The amount of light they absorb depends on their color. Black particles (e.g. rubber particles worn off automobile tires) are strong absorbers. Under some circumstances absorbing particles may be a significant contributor to visibility degradation. When light is scattered by particles it is not absorbed, but rather its direction is changed so that a haze appears in the air and objects cannot be seen as clearly. The light scattering ability of particles is primarily determined by the size of the particle, with those between 0.1 and 1 micrometer having the highest opacity. The smaller particles found in the air are principally the products of combustion or are produced from gases in the atmosphere, such as sulfate particles from sulfur dioxide. The larger particles are often from road dust or natural sources.

If there is no absorption of light by gases or particles, visibility can be measured in terms of the light scattering of the gas molecules and the

particles. The light scattering coefficient measures the amount of light scattered by a given concentration of a certain size particles. The natural scattering of light by air molecules has a numerical value of approximately 1×10^{-5} per meter at 3000 ft. elevation. This defines the maximum visibility on very clear days. As the number of particles in the air increases, the coefficient increases. If the air contains particles with a light scattering coefficient of 1×10^{-5} per meter, then the visibility will be only half what it would be on very clear days. When the light scattering coefficient of the particles is 2×10^{-5} per meter, then the visibility is only one-third of what it could be.

The actual observed visibility is determined by the scattering coefficient of the air and particles over the entire distance between the observer and the object viewed. The scattering due to particles will tend to be higher in and near cities and places of human activity where there are more particles. Thus a measurement of scattering coefficient of particles made in a city will tend to overstate the reduction in visibility that observers will see when looking out, away from the city. However, it is not necessary for an object to disappear for visibility to be affected. Thus a nearby object can appear hazy even though objects much further away are still visible.

The small particles that cause the most visiblity degradation are believed to be the portion of total suspended particulate matter that has the largest effect on health, as they are more likely to enter the lungs and remain there. However, there are no published studies attempting to relate observed health effects to visibility degradation, or the measured light scattering coefficient of particles.

Measurement of Visibility

Visibility degradation may be measured, and regulated, either by directly noting the distance objects can be seen (the visual range) or by measuring the scattering and absorption of light that causes visibility degradation. A careful review of all the techniques for directly measuring visural range led the Department to conclude that there were no reliable methods that were well adapted to the regulatory process.

Since measurements of gas absorption and gas scattering are not necessary to understand visibility impairment in Montana, attention was focused on instruments that measure particle scattering and absorption. Among these instruments, only the integrating nephelometer, which measures only particle scattering, can be efficiently used as a field monitoring instrument. Since particle scatter is most often the dominant cause of visibility degradation, the use of the integrating nephelometer to measure particle scattering coefficient, is more likely to provide useful visibility measurements than the use of other instruments.

The description of the measurement method in the draft EIS and proposed rule did not entirely specify the procedure to be used. Also it is now proposed that the inlet to the nephelometer be heated to reduce the humidity of the air sampled, and the photo response of the nephelometer is to be specified as green light. As the nephelometers currently being used by the Air Quality Bureau have a blue light response characteristic, it will be necessary to apply an approximate correction factor (Ruby and Waggoner, 1980).

Selection of Ambient Air Quality Standard

Human Health Effects

Effects upon human health from particulate matter in the air are considered in the standard for total suspended particulate matter.

Welfare Effects

Much of Montana's natural beauty derives from the scenic vistas which may be found in virtually every region of the state. In addition to enhancing the quality of life for those living in the state, the scenic areas attract many visitors, thereby playing a major role in the state's overall economy. As human activity increases, the amount of particulate matter in the air also increases, thereby degrading visibility. An ambient air quality standard establishing a maximum acceptable level of light scattering particles can serve to prevent such degradation.

Recommended Standard

In order to control the degradation of visibility, the Department recommends that the annual average of the particle scattering coefficient should not exceed 3×10^{-5} per meter in areas designated Class I, to protect the public welfare.

At present there is no Montana or federal standard for visibility. The Federal Clean Air Act Amendments of 1977 require the Environmental Protection Agency to develop regulations to protect the visibility in mandatory Class I areas. Montana and all other states will be required to develop an implementaion plan to accomplish the objectives spelled out in these regulations. The regulations are expected to be adopted by November, 1980. By recommending a standard applicable to Class I areas only, the Department intends to protect the state's principal scenic resources without unreasonably limiting other activities.

Considerations of Practicability

In the draft EIS the Department recommended a visibility standard for the entire state. Such a standard could affect certain sources which emit large amounts of fine particles. The fine particles that scatter light most strongly may be directly emitted as a particle from a smokestack or may be created in the air by a chemical reaction. Combustion sources, including slash burning, are the primary source of directly emitted fine particles. Particulate fumes from certain metallurgical operations is a locally significant source of fine particles. Control of fine particles from industrial sources can be achieved with a baghouse or a high energy scrubber. Sulfur dioxide can react in the atmosphere to create fine sulfate particles. Control of sulfur dioxide may be accomplished by various scrubbing and flue gas desulfurizaiton techniquues. All the techniques used to control fine particles and sulfur dioxide are expensive to install and/or to operate.

Particle scattering coefficeint currently is being measured with nephelometers at several sites in Montana. During 1979 an annual average value of $2.2 \times 10^{-5}\ m^{-1}$ (corrected to an equivalent green light value) was recorded at a site 600 feet west of the Scobey border crossing station. This is an isolated, agricultural location. An instrument in Missoula averaged $3.8 \times 10^{-5}\ m^{-1}$ during the summer of 1978, but high readings during the winter heating season resulted in an annual average value of $14.2 \times 10^{-5}\ m^{-1}$. Instruments in urban and semiurban areas in Butte and Kalispell showed similar results. These data are described in detail elsewhere in this final EIS. (chapter 2, p. 121).

As described in the Draft EIS at pp. 6-7 a classification system under the Montana rule on prevention of significant deterioration, (Rule 16.2.14(1)-S1418) has been developed to regulate the amount of increased air pollution that will be permitted in different parts of the state. In areas designated

Class I, only a miniscule increase in pollution will be allowed. In these areas, clean air and good visibility have been determined to take precedence over other values, such as substantial growth in residential population or industrial development. The relative importance of such values will be the critical element in determining which areas will be designated Class I in the future.

Most Class I areas are federal lands of high recreational and scientific value, such as National Parks or wilderness areas. Montana has two National Parks, Glacier and a portion of Yellowstone, and thirteen wilderness areas. Ten of the wilderness areas were established prior to the enactment of the Federal Clean Air Act Amendments of 1977 and are therefore "mandatory Class I areas" where the most stringent rules apply. One Indian reservation has been designated as a Class I area and two other Indian reservations are actively considering such designation. If this occurs, a total of 10,000 square miles would be classified Class I, approximately seven percent of the state's land area. Class I areas in Montana are located in the map found on p. 5 of this EIS.

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FLUORIDES

The Department has reviewed the literature on the effects of gaseous and particulate fluoride on public health and welfare. The principal findings in the literature were described in the draft EIS at pp. 189-213.

General Findings

Human Health

There is no evidence in the literature that human health is adversely affected at ambient concentrations found in Montana. The average ambient level necessary to cause adverse effects in humans has been reported to be near 3 ppm for an eight-hour period (Hodge and Smith, 1977); this is roughly 230 times higher than the highest 24-hour ambient recording ever recorded in the state. Atmospheric fluorides can contribute to elevated levels of body fluoride in residents of fluoride contaminated areas provided their diet comes principally from locally grown foodstuffs (Tsunoda *et al*. 1972; Rippel *et al*. 1967). The long-term effects in humans of an increased fluoride body burden has not been determined.

Vegetation

Gaseous fluorides are the most toxic to plants of all air pollutants (Weinstein, 1977). Particulate fluoride is not a direct threat to vegetation but may accumulate on plant surfaces posing a health hazard to foraging animals (NAS, 1971).

Gaseous fluorides enter the plant through pores in the leaves (stomata), adversely affecting a variety of biological functions. Fluoride may injure vegetation either by direct toxic action after a short-term high-level exposure or by accumulating excessively in plant tissue over time at lower concentrations. Plants do not appear to have a specific threshold level of fluoride below which no adverse impacts are noted. Evidence indicates that fluoride begins to

injure vegetative structures when plant fluoride levels are slightly above normal background levels (Carlson, 1978).

Adverse impacts to vegetation have been measured in a number of ways. The most direct measure is through observations of visible damage to certain portions of the plant. Other indications of adverse impacts are reductions in photosynthesis and increases in respiration (signifying stress), or reductions in growth and productivity of plants and ecosystems. Visible damage is considered to provide a conservative estimate of the adverse impacts of fluoride on vegetation, since biological processes are altered and growth and productivity reduced before injury symptoms become visible (Treshow et al. 1967).

Field and laboratory studies show the level of fluoride capable of causing visible injury at various exposure durations. These experiments indicate ponderosa pine is one of the most fluoride sensitive of all commercial plant species. Experiments on the short term levels capable of causing visible injury to ponderosa pine indicate a threshold below 1.2 ppb for a continuous 24-to-48 hour exposure (Solberg et al. 1955; Adams et al. 1956a). At longer exposures ponderosa pine shows significant visible injury at 0.49 ppb for 9 to 15 days of exposure (Solberg et al. 1955; Adams et al. 1956b). The severity of visible injury to ponderosa pine has been shown to increase with increasing fluoride levels over a fixed exposure period. Sidhu (1977) found that thresholds for visible injury in moderately resistant eastern forest trees occurred at fluoride levels of 0.45 ppb/31 days for Balsam fir; 0.39-0.70 ppb/26 days for eastern larch; and 0.41-0.44 ppb/20 days for white birch and alder.

Several Montana tree species are considered susceptible to fluoride pollution (Treshow and Pack, 1970) including Douglas fir, western larch, lodgepole pine, and ponderosa pine. Carlson and Dewey (1971) agree with this class-

ification, adding western white pine to the list of susceptible Montana tree species.

Forest vegetation in Montana has been shown to accumulate 34 ug/g fluoride when exposed to growing season average fluoride levels between 0.13 to 0.21 ppb (Carlson and Dewey 1971; EPA, 1974). Carlson (1978) indicated that accumulated tissue fluoride caused growth reductions in Montana trees. His work showed that the higher the level of fluoride level in conifer foliage, the greater the growth loss in these trees.

Coniferous trees appear sensitive to fluoride because they retain foliage for more than one year. This allows for longer exposures and higher fluoride accumulation. Sidhu (1978) concludes that fluorides exert a toxic influence in conifer foliage through two years of needle retention.

Other range and forage plants also have been shown to accumulate tissue fluoride when exposed to a contaminated atmosphere. Field measurements by Israel (1974) indicate a level of airborne fluoride between 0.21 and 0.32 ppb for 30 days can lead to fluoride accumulations of 35 ug/g in orchard grass and perennial ryegrass. Carlson and Hammer (1974) presented evidence that a strong statistical relationship exists among fluoride accumulation, insect infestations and growth loss in conifer forests.

Livestock and Other Animals

Excessive fluoride exposure to cattle and other animals over long periods results in chronic fluorosis; most often consisting of all or some of the following: brown discolored teeth with excessive wear, elevated bone and systemic tissue fluoride levels, reductions in milk yields, reductions in weight gain, increase in bone abnormalities, and a higher incidence of lameness. The type and severity of symptoms associated with chronic fluorosis in animals is governed by a number of variables: quantity of fluoride ingested, duration of

ingestion, type of fluoride ingested, age of the animal at the time of ingestion, level of nutrition, stress factors, and individual biological response (Greenwood et al. 1964).

A number of controlled feeding experiments have evaluated chronic fluorosis in livestock (Suttie, 1969; Suttie et al. 1972; Suttie et al. 1961; Suttie and Faltin, 1973; Greenwood et al. 1966; McLaren and Merriman 1975; Hobbs and Merriman 1962; Hobbs et al. 1954). These experiments determined that beef and dairy cattle have the lowest tolerance to dietary fluoride of all domestic animals. Wildlife tolerances are not known but it is generally accepted that if cattle are protected, the area also will be safe for wildlife (Suttie, 1977).

The relationship found in long-term controlled feeding experiments between the fluoride content of the diet and the development of various symptoms in cattle is summarized in Table 6.

Table 6

Symptom*	Moisture free fluoride in diet (ug/g)
Mottling of teeth	20-30
Excessively thin tooth enamel	40-50
Slight bone abnormalities	30-40
Moderate bone abnormalities	40-50
Significant increase in lameness	50
Decreased milk production	50
5000 ppm skeletal fluoride at 5 years	50
Urine fluoride of 25 ppm	40-50

*Symptoms are those which occur after feeding of cattle from 2-3 months of age til 7.5 years of age.

Results indicate that continual feeding of fluoride in excess of 50 ug/g to young heifers through maturity and production cycles will cause all the general signs of fluoride toxicity in these animals. Heifers fed less than 50 ug/g

fluoride will have some incisor mottling and slight indications of bone abnormalities. These animals will also show an increase in urine and tissue fluoride concentrations and microscopic alterations in tooth and bone formation. Controlled feeding experiments indicate that changes associated with continual feeding of less than 40 ug/g fluoride have no known adverse effect on the animals.

Controlled feeding experiments also show that short-term high levels of fluoride can cause tooth damage. Results from these studies indicate that cattle will have excessively thin tooth enamel and a tendency for rapid tooth wear if fed greater than 40 ug/g dietary fluoride during the period of tooth development (from 2 months to approximately 30 months of age). It has been shown that these animals can have tooth malformations without other symptoms of fluoride toxicity if their dietary fluoride content is subsequently reduced. Conversely, cattle may show other longer term symptoms of fluorosis but not tooth damage if they are maintained on low fluoride during tooth development then fed high dietary fluoride.

It is generally concluded by scientists studying cattle fluorosis that while controlled feeding experiments are accurate in predicting the fluoride content of feed that can cause fluoride toxicity, these experiments do not necessarily indicate an average forage fluoride level capable of causing equivalent effects in cattle raised under pasture or range conditions. Variables such as the level of nutrition, stress, and type of fluoride ingested are quite different in field situations than in controlled feeding experiments.

Many field surveys have attempted to determine forage levels capable of causing chronic fluorosis in cattle (Krook and Maylin, 1979; McLaren and Merriman, 1975; Miles et al. 1978; Greenwood et al. 1955). In general all field studies conducted to date suffer from inadequate forage fluoride sampling

over the exposure cycle of experimental animals. However, in the few cases where data are sufficient, the studies suggest that animals ingesting fluoride levels comparable to those administered in feeding experiments exhibit more severe effects. The hypothesized reasons for this difference in effects are fluctuating high and low fluoride levels (Suttie et al. 1974), exposure to fluoride at fetal or early stages of calf development (Krook and Maylin, 1979) and/or inadequate nutrition (Crampton, 1968; McLaren and Merriman, 1975; Suttie and Faltin, 1975).

Evidence shows that animals and insects accumulate excessive fluoride near pollution sources in Montana. Mule deer, elk, and honey bees have been observed to accumulate up to 17 times as much fluoride as species sampled from noncontaminated areas of the state.

Measurement of Fluoride

Hydrogen fluoride is collected by the double tape sampler method described in the draft EIS. It is reliable and accurate within the expected range of ambient concentrations found in Montana. Laboratory measurement of double tape samples will utilize the semi-automated alizarin fluoride blue-lanthanum colorimetric method.

Bicarbonate-coated-tube samplers have been approved by the Air Quality Bureau as equivalent to the double tape sampler. This method currently is used by the Anaconda Aluminum reduction facility.

Concentrations of fluoride in forage in collected samples will use the semi-automated alizarin fluoride blue-lanthanum colorimetric method.

Selection of Ambient Air Quality Standard

Human Health Effects

Fluorides do not endanger human health at ambient levels found in Montana.

Welfare Effects

Fluoride is highly toxic to cattle and vegetation, particularly the vegetation of western forests. In Montana agriculture and timber production are the first and fourth largest primary industries.

The area surrounding the largest fluoride source in Montana, the Anaconda Aluminum Company (AAC) aluminum reduction facility in Columbia Falls is considered to be some of the most productive timberland in the state. Glacier National Park is roughly 10 miles downwind from the AAC. Fluoride has been found to be accumulating in the Glacier Park ecosystem since sampling began in 1969 (Hall, 1978). Accumulated plant fluoride has caused visible plant damage potentially reducing the stability of the park ecosystems and the aesthetic and recreational enjoyment of park visitors. Valley bottoms near the AAC and the other major source of fluoride, the Stauffer Chemical Company (SCC) at Ramsay are used for raising beef and dairy cattle.

In light of the above considerations, the Department determined that there is a need to protect Montana's agriculture and recreational amenities from significant damage by fluoride pollution.

Recommended Standards

Protection of vegetation by gaseous fluoride standards should be predicated on the aesthetic, economic, and ecological usefulness of sensitive vegetation near Montana's fluoride emitting industries. Visible injury and excessive fluoride accumulation in vegetation are the bases for determining the appropriate gaseous fluoride standards.

Visible injury is used as a criterion because it signifies a decrease in the total amount of photosynthetic area by which plants transfer sunlight into biomass. Such injury therefore is an indicator of long-term growth and yield losses. It is probable that visible injury is a conservative predictor of potential economic loss from fluoride pollution. Scientific evidence strongly

suggests that growth reductions are possible in the absence of visible injury. Visible injury is also a criterion for judging the aesthetic losses to vegetation in area of scenic beauty and in ornamental plantings.

Excessive fluoride accumulation in plant tissue also was used as basis for establishment of the gaseous fluoride standards. Elevated tissue fluoride has been correlated with growth suppression and visible injury. Excessive plant fluoride also leads to accumulated fluoride in other components of ecosystems such as insects and small mammals.

24-Hour Standard

Most commercial western forest trees are sensitive to gaseous fluorides. Short-term studies on ponderosa pine indicate that a threshold for causing visible injury occurs below 1.2 ppb for an exposure of from 24 to 48 hours. Similar results can be predicted at or near this level for most other forest trees found in Montana. In order to prevent visible damage to Montana trees, the Department recommends a hydrogen fluoride air quality standard of 1.0 ppb, 24-hour average, not to be exceeded more than once a year. This standard should reduce the likelihood of growth losses and rapid fluoride accumulations in major timber species. It is unclear, however, if the standard would protect all other plant species sharing these or other ecosystems.

There is no federal 24-hour hydrogen fluoride standard. The current Montana rule is 1.0 ppb total fluoride, averaged over a 24-hour period. The proposed standard measures only gaseous fluoride, compared to the total fluoride measured under the old rule. The Department estimates indicate the new proposed standard would allow 10-15 percent higher gaseous fluoride concentration than the current rule.

30-Day Standard

It is apparent from the literature that fluoride accumulates in plants

with increasing duration of exposure and that visible plant damage and growth losses are co-related with elevated tissue fluoride levels. Experimental exposures show that sensitive forest trees are damaged by gaseous fluoride at 0.50 ppb for a 9-15 day exposure. More tolerant eastern forest species are damaged at concentrations between 0.39 and 0.70 ppb for exposure periods lasting 20 to 31 days. Experiments on fluoride accumulation in certain forage crops suggest that approximately 35 ug/g will accumulate at fluoride levels between 0.21 and 0.32 ppb for 30 days. The Department therefore has determined the necessity for a 30-day average ambient fluoride standard and proposes a 0.30 ppb level, not to be exceeded more than once a year. This standard would protect forest trees found in Montana from visible damage. It also would reduce accumulation of fluoride in forage crops.

There is no federal 30-day standard for hydrogen fluoride. The present Montana gaseous rule is 0.30 ug/cm^2/28 days. This standard is being discontinued because of the imprecision in the measurement technique and because it is difficult to relate the measurement to ambient air levels and ultimately to primary source emission reductions. The proposed 30-day standard is roughly equivalent to a 0.46 ug/cm^2/28 days standard under the present rule. It is therefore a relaxation of the present rule by 50 percent.

Forage Standard

The adverse impact of high forage fluoride on livestock is well accepted in the scientific community. The only practical method of protecting livestock from excessive fluoride in forage is a forage standard.

The intent in setting a forage standard was to protect livestock from fluoride levels high enough to decrease the productivity of the animals or render them unsuitable for sale at a fair market value.

Controlled feeding experiments where animals have shelter and optimum feed indicate that the annual average of fluoride in forage should not exceed

40 ug/g if there is to be no reduction in the performance of any domestic animals. Field experiments suggest that a level somewhat below 40 ug/g is necessary to protect cattle and dairy cows in situations of environmental and nutritional stress. Controlled and field experiments also present evidence that forage levels exceeding 50 ug/g are detrimental to normal teeth development if administered during the period of tooth development. The Department therefore recommends fluoride in forage not be allowed to exceed 35 ug/g annual average, with no monthly levels to exceed 50 ug/g. This standard also should protect wildlife from fluoride damage.

There is no federal fluoride forage standard. The present state rule is 35 ug/g in vegetation, not to be exceeded. The proposed forage standards are not strictly comparable to the present state rule. The proposed standards are annual and monthly averages of forage consumed by wildlife and domestic animals.

Considerations of Practicability

Based upon studies by the Department it appears the AAC will meet the proposed hydrogen fluoride standards when the current emission reduction program is completed. No analyses were conducted on whether the AAC would also comply with the proposed forage standard but it appears likely that it would, after completion of its pollution control program.

Costs to the AAC to meet the proposed standards would be insignificant (Otis *et al*. 1979). The emission reduction program to which the Company is already committed will enable recovery of process materials which will more than compensate for the costs of control.

Any reductions of ambient fluoride levels beyond those available through the current control program would necessitate costly roof scrubbers requiring an investment of 24 million dollars. An expenditure of this order does not appear justifiable when compared to the incremental increase in welfare benefits that would result.

A similar analysis by the Department strongly suggests that the Stauffer Company will comply with the proposed short-term hydrogen fluoride standard. It appears that the Company would meet the monthly hydrogen fluoride and forage standards after the current control program becomes fully operational. Justification of the costs and benefits of additional expenditures by Stauffer are uncertain without a more detailed estimation of environmental and engineering costs (Otis et al. 1979).

In the case of these two facilities, the primary benefit of the proposed standards would be to ensure maintenance and operation of the emission control systems to minimize impacts upon ambient air quality, thereby affording adequate protection to the environment. Overall, the adoption of enforceable ambient fluoride standards would protect animals, plants, timber and other vulnerable portions of the environment from the emissions of present and future sources of fluoride.

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HYDROGEN SULFIDE

The Department has reviewed a broad literature on the effects of hydrogen sulfide on the public health and welfare. The principal features of that literature were described in the draft Environmental Impact Statement at pp. 220-227.

General Findings

Human Health

Very few intensive studies have been made of the health effects of hydrogen sulfide exposures. Eye damage was found among workers chronically exposed to hydrogen sulfide in excess of 20 ppm (Barthelemy, 1939). No laboratory studies of the effects of hydrogen sulfide on people at concentrations less than 10 ppm were found in the scientific literature by the Department.

A brief study in Terre Haute, Indiana did observe significant health responses during a series of high concentration episodes. During one episode complaints were received of nausea, vomiting, and shortness of breath. A few days later the Public Health Service investigations team was present in the affected area during an episode. Members of the team complained of nausea and throat irritation. Air quality monitors in the area were reported to read approximately 0.10 ppm, one-hour average during the episode (Public Health Service, 1964).

Welfare

Hydrogen sulfide is a highly odorous gas which can arouse significant public annoyance at very low concentrations and has been associated with adverse health responses, such as headaches, nausea, and shortness of breath, at higher concentrations. Damage to vegetation and agricultural crops has been reported from exposure to hydrogen sulfide.

Most people will detect the odor of hydrogen sulfide at concentrations between 0.0015 and 0.0075 ppm (Wilby, 1969). Recent attempts have been made to measure the degree of public annoyance with varying concentrations of odors in communities where industry frequently emits malodorous gases, including hydrogen sulfide (Jonsson *et al.*, 1975 and Deane and Sanders, 1978). However these studies did not separate the response to hydrogen sulfide from the other co-existing malodors. Other studies that have attempted to generalize annoyance reactions to malodors (Dravnieks and O'Neill, 1979) have not progressed to the point that a general rule for ambient standards for odors can be set out.

The only sizeable community studies of the effects of hydrogen sulfide exposures were conducted by the U. S. Public Health Service in the early 1960s. The Terre Haute study was described above. A six-month Public Health Service study in the adjoining cities of Lewiston, Idaho and Clarkston, Washington did not identify any clear health-related responses to the hydrogen-sulfide pollution, but did determine that about two-thirds of the residents were "somewhat bothered" by the air pollution while about one-sixth were bothered "quite a lot" (Public Health Service, 1965). The highest concentrations of hydrogen sulfide were reported to be 0.05 to 0.07 ppm, two-hour average(Public Health Service, 1964a).

The measurement method used in these two community studies has since been found to substantially understate the actual concentrations of hydrogen sulfide in the air (Bamesberger and Adams, 1969 and Siu *et al.*, 1971). The results of these comparative studies of measurement techniques may be utilized to translate the reported data into terms consistent with the measurement technique that is being recommended for use with this standard. If this were done, the maximum hydrogen sulfide concentrations expected not more than once a year in the Lewistown-Clarkston study would be approximately 0.15 ppm and the concentration associated with the episode in Terre Haute would be approximately 0.25 to 0.30 ppm.

Several researchers (Thompson and Kats, 1978 and McAllister, 1976) have observed the onset of damage to conifers in the range of 0.03 to 0.10 ppm of hydrogen sulfide over very long periods. Substantial damage to agricultural crops also was reported by Thompson and Kats (1978) at 0.3 ppm for one month.

Measurement of Hydrogen Sulfide

Hydrogen sulfide is routinely measured by the methylene blue spectrophotometric method described in the draft EIS. It is accurate and reliable within the expected range of ambient concentrations.

Automated methods for the measurement of hydrogen sulfide have been developed. A gas chromatography technique, as a condition of a permit, is currently in use by a major industrial source in Montana.

Selection of Ambient Air Quality Standard

Human Health Effects

As described in the draft EIS, there is very limited evidence that persons with pre-existing heart and lung disease and psychological disorders may be more strongly affected than others. However, there is no indication in the scientific literature just how much more sensitive they may prove to be than the average population.

Based on the Public Health Service reports on the Lewiston-Clarkston and Terre Haute situations, the Department has identified 0.15 ppm to 0.30 ppm of hydrogen sulfide for one hour as the range of concentrations likely to be associated with the onset of nausea, headaches, and similar health responses in the general population.

The health effects occurring due to sporadic exposures at less than 10 ppm are believed by the Department to be reversible and not likely to result in permanent damage. However, they are more than minor irritations and should be avoided. Both the data presented in the Public Health Service studies and

the lack of other studies leaves substantial uncertainty in the identification of a minimum concentration below which the public health and safety can be said to be fully protected.

Welfare Effects

The unpleasant odors associated with hydrogen sulfide can be a source of significant public annoyance. An ambient air quality standard establishing a maximum acceptable level of this air contaminant is therefore desirable to reduce public inconvenience.

Recommended Standard

Headaches, nausea, and similar health related responses are expected to be observed in general populations at one-hour concentrations of 0.30 ppm. An air quality standard of 0.10 to 0.20 ppm might be necessary to protect the public health. However, if concentrations near this level were being experienced in populated areas a significant number of times during the year substantial public annoyance could be expected. After carefully considering the practicability of a standard to control exposure to hydrogen sulfide odors, the Department recommends that a one-hour standard of 0.05 ppm, not to be exceeded more than once a year, be adopted to protect the public welfare.

The current Montana standards for hydrogen sulfide are 0.05 ppm averaged over thirty minutes, not to be exceeded more than twice in one year and 0.03 ppm for thirty minutes, not to be exceeded more than twice in any five consecutive days. There is no Federal ambient air quality standard for hydrogen sulfide. The proposed standard will be marginally less stringent than the present Montana standard. A one-hour averaging period was selected to be consistent with other standards being proposed by the Department.

Consideration of Practicability

The primary sources of hydrogen sulfide in Montana are sanitary sewage treatment lagoons, pulp mills, and oil refineries. Control of hydrogen sulfide emissions from waste water treatment lagoons is often accomplished by aerating the ponds to prevent the growth of hydrogen sulfide producing bacteria. Control of process sources is usually accomplished with a liquid scrubber or after-burner. None of these control techniques is inexpensive, but all are reasonably available to the owners and operators of the sources.

At present the only monitoring of hydrogen sulfide ambient concentrations is being conducted by a pulp mill in Missoula. During July of 1978 and 1979 a significant number of one-hour average concentrations in excess of 0.04 ppm were recorded. One measurement was above 0.06 ppm in 1979 and five in 1978. Some of these were associated with maintenance of the waste water treatment ponds which involved shutting down the aeration equipment. Other high measurements may have been due to warm weather which could have encouraged the growth of the hydrogen sulfide producing bacteria in the ponds.

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APPENDIX A

PROPOSED RULES ON MONTANA AMBIENT AIR QUALITY STANDARDS

RULE I PURPOSE In accordance with section 75-2-102, MCA, of the Montana Clean Air Act, it is the primary purpose of this sub-chapter to establish ambient air quality standards which protect human health and safety, and to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state.

RULE II DEFINITIONS In this sub-chapter, the following words and phrases shall have the following meanings:

(1) "Act" means the Montana Clean Air Act.

(2) "Ambient air" means that portion of the atmosphere, external to buildings, to which the general public has access.

(3) "Ambient air quality standards" means a permissible level of an air contaminant in the ambient air as defined by the maximum frequency with which a specified level may be exceeded or by a maximum level of an air contaminant in or on body or plant tissues.

(4) "Annual average" means an arithmetic average of all valid recorded averages of any 12 consecutive calendar months provided that:

(a) at least forty 24-hour average recorded values are necessary and each of these values must be separated from the previous value by at least 6 days, or

(b) at least 5840 hourly average valid recorded values are necessary.

(5) "Approved equivalent method" means any method of measuring concentrations of air contaminants regulated in this sub-chapter which has been approved as an equivalent method by the U.S. Environmental Protection Agency pursuant to Title 40, Part 53, Code of Federal Regulations or which has been approved by the department. Methods approved by the department are kept on file and are available for inspection and copying.

(6) "Carbon monoxide" means the gas having the molecular composition of one carbon atom and one oxygen atom.

(7) "Department" means the department of health and environmental sciences.

(8) "Eight hour average" means the arithmetic average of all valid recorded values during any consecutive eight hours but not less than six valid hourly averages.

(9) "Fluoride" means fluorine combined with one or more other substances.

(10) "Forage" means any plant part which is grazed or browsed.

(11) "Grams per square meter" (gm/m^2) means a concentration numerically equal to the mass of an air contaminant (in grams) deposited on one square meter of surface.

(12) "Hourly average" means an arithmetic average of all valid values recorded between the first minute and sixtieth minute of the hour (e.g. 1:00 to 2:00), but not less than two-thirds of the data obtainable from the monitoring device during the hour, or an integral sample of more than 40 minutes.

(13) "Hydrogen fluoride" means the gas having the molecular composition of one fluorine atom and one hydrogen atom.

(14) "Hydrogen sulfide" means the gas having molecular composition of one sulfur atom and two hydrogen atoms.

(15) "Lead" means elemental lead or lead in combination with any other substance.

(16) "Micrograms per cubic meter" (ug/m^3) means a concentration numerically equal to the mass of an air contaminant present (in micrograms) in a one cubic meter of air, corrected to standard conditions.

(17) "Micrograms per gram" (ug/g) means a concentration numerically equal to the mass of an air contaminant (in micrograms) in one gram of dry material.

(18) "Ninety day average" means an arithmetic average of all valid recorded values during any ninety consecutive days. The minimum number of valid recorded values shall be ten provided that each of these values must be separated from the previous value by at least six days.

(19) "Nitrogen dioxide" means the gas having the molecular composition of one nitrogen atom and two oxygen atoms.

(20) "Ozone" means the gas having the molecular composition of three oxygen atoms.

(21) "Particle scattering coefficient" means the fractional change in the light intensity per meter of sight path due to particulate matter.

(22) "Particulate matter" means any material, except water in an uncombined form, that is or has been airborne and exists as a liquid or a solid at standard conditions.

(23) "Parts per billion" (ppb) means a concentration of an air contaminant numerically equal to the volume of a gaseous air contaminant present in one billion volumes of air at the same conditions of temperature and pressure.

(24) "Parts per million" (ppm) means a concentration of an air contaminant numerically equal to the volume of a gaseous air contaminant present in one million volumes of air at the same conditions of temperature and pressure.

(25) "Standard conditions" means a temperature of 25^{o} Celsius and a pressure of 760 millimeters of mercury.

(26) "Sulfur dioxide" means the gas having the molecular composition of one sulfur atom and two oxygen atoms.

(27) "Thirty-day average" means an arithmetic average of all recorded values during any consecutive thirty days, but not less than twenty valid twenty-four hour average recorded values or an integral sample of more than twenty days.

(28) "Twenty-four hour average" means an arithmetic average of each valid recorded value during any consecutive twenty-four hours, but not less than eighteen valid hourly averages or an integral sample of more than eighteen hours.

(29) "Valid recorded value" means data recorded, collected, transmitted and analyzed as required by Rule IV of this sub-chapter.

(30) "Year" means any 12 consecutive months.

RULE III ENFORCEABILITY Any person who violates any provision of this sub-chapter shall be subject to the enforcement provisions of the act. Except as otherwise provided in this sub-chapter, the ambient air quality standards are applicable throughout the state of Montana.

RULE IV METHODS AND DATA Except as otherwise provided in this sub-chapter, all sampling and data collection, recording, analysis and transmittal, including but not limited to site selection, calibrations, precision and accuracy determinations must be performed as specified in Title 40, Part 58, (Appendices A through E), Code of Federal Regulations (1979). If a valid recorded value comprises in whole or in part an exceedance of an ambient air quality standard, such recorded value shall not comprise in whole or in part an exceedance of the same ambient air quality standard.

RULE V AMBIENT AIR QUALITY STANDARDS FOR CARBON MONOXIDE

(1) No person shall cause or contribute to concentrations of carbon monoxide in the ambient air which exceed any of the following standards:

(a) Hourly average: 23 parts per million, hourly average, not to be exceeded more than once per year.

(b) Eight-hour average: 9 parts per million, eight-hour average, not to be exceeded more than once per year.

(2) Measurement method: For determining compliance with this rule, carbon monoxide shall be measured by the non-dispersive infra-red method, as more fully described in Title 40, Part 50 (Appendix C), Code of Federal Regulations (1979), or by an approved equivalent method.

RULE VI AMBIENT AIR QUALITY STANDARDS FOR FLUORIDES

(1) No person shall cause or contribute to concentrations of fluorides in the ambient air or in forage which exceed any of the following standards:

(a) Hydrogen fluoride

(i) Twenty-four hour average: 1 part per billion hydrogen fluoride, 24-hour average, not to be exceeded more than once per year;

(ii) Thirty-day average: 0.30 parts per billion hydrogen fluoride, 30-day average, not to be exceeded more than once per year.

(b) Fluoride in or on forage: 35 micrograms per gram fluoride in or on forage, annual average, with no monthly average to exceed 50 micrograms per gram.

(2) Measurement method for hydrogen fluoride: For determining compliance with this rule, concentrations of hydrogen fluoride shall be measured by the double tape sampler, as more fully described in "Methods of Air Sampling and Analysis, Second Edition" (1977) Method No. 42222-02-72T, as modified by the addition of a heated stainless steel sample inlet line, with the NaOH - impregnated tape analyzed by the semiautomated method discussed in "Methods of Air Sampling and Analysis, Second Edition" (1977) Method No. 122-2-02-68T, section 7.3, or by an approved equivalent method.

(3) Sampling method for fluoride in or on forage: For determining compliance with this rule, concentrations of fluorides in or on forage shall be determined from forage collected according to a sampling protocol approved by the department and analyzed by the semiautomated method, as more fully described in "Methods of Air Sampling and Analysis, Second Edition" (1977), Method No. 122-2-02-68T, provided that the surfaces of the plant material are not to be washed, or by an approved equivalent method.

RULE VII AMBIENT AIR QUALITY STANDARD FOR HYDROGEN SULFIDE (1) No person shall cause or contribute to concentrations of hydrogen sulfide in the ambient air which exceed the following standard:

(a) Hourly average: 0.05 parts per million, 1-hour average, not to be exceeded more than once per year.

(2) Measurement method: For determining compliance with this rule, hydrogen sulfide shall be measured by the methylene blue spectrophotometric method, as more fully described in "Methods of Air Sampling and Analysis, Second Edition" (1977) Method P & CAM 126-6, or by an approved equivalent method.

RULE VIII AMBIENT AIR QUALITY STANDARD FOR LEAD (1) No person shall cause or contribute to concentrations of lead in the ambient air which exceed the following standard:

(a) Ninety-day average: 1.5 micrograms per cubic meter of air, 90-day average, not to be exceeded.

(2) Measurement method: For determining compliance with this rule, lead shall be measured by the atomic absorption method, as more fully described in Title 40, Part 50 (Appendix G), Code of Federal Regulations (1979), or by an approved equivalent method.

RULE IX AMBIENT AIR QUALITY STANDARDS FOR NITROGEN DIOXIDE (1) No person shall cause or contribute to concentrations of nitrogen dioxide in the ambient air which exceed any of the following standards:

(a) Hourly average: 0.30 parts per million, 1-hour average, not to be exceeded more than once per year;

(b) Annual average: 0.05 parts per million, annual average, not to be exceeded.

(2) Measurement method: For determining compliance with this rule, nitrogen dioxide shall be measured by the chemiluminescence method, as more fully described in Title 40, Part 50, (Appendix F), Code of Federal Regulations (1979), or by an approved equivalent method.

RULE X AMBIENT AIR QUALITY STANDARD FOR OZONE (1) No person shall cause or contribute to concentrations of ozone in the ambient air which exceed the following standard:

(a) Hourly average: 0.10 parts per million 1-hour average, not to be exceeded more than once per year.

(2) Measurement method: For determining compliance with this rule, ozone shall be measured by the chemiluminescence method, as more fully described in Title 40, Part 50 (Appendix D), Code of Federal Regulations (1979), or by an approved equivalent method.

RULE XI AMBIENT AIR QUALITY STANDARD FOR SETTLED PARTICULATE MATTER (1) No person shall cause or contribute to concentrations of particulate matter in the ambient air such that the mass of settled particulate matter exceeds the following standard:

(a) Thirty-day average: 10 grams per square meter, 30-day average, not to be exceeded.

(2) Measurement method: For determining compliance with this rule, settled particulate matter shall be measured by the dust fall method, as more fully described in "Methods of Air Sampling and Analysis, Second Edition" (1977), Method No. 21101-0170T, or by an approved equivalent method.

RULE XII AMBIENT AIR QUALITY STANDARDS FOR SULFUR DIOXIDE

(1) No person shall cause or contribute to concentrations of sulfur dioxide in the ambient air which exceed any of the following standards:

(a) Hourly average: 0.50 parts per million, 1-hour average, not to be exceeded more than once per year;

(b) Twenty-four hour average: 0.10 parts per million, 24-hour average, not to be exceeded more than once per year;

(c) Annual average: 0.02 parts per million, annual average, not to be exceeded.

(2) Measurement method: For determining compliance with this rule, sulfur dioxide shall be measured by the pararosaniline method as more fully described in Title 40, Part 50 (Appendix A) Code of Federal Regulations (1979), or by an approved equivalent method.

RULE XIII AMBIENT AIR QUALITY STANDARDS FOR TOTAL SUSPENDED PARTICULATE MATTER (1) No persons shall cause or contribute to concentrations of particulate matter in the ambient air which exceed any of the following standards:

(a) Twenty-four hour average: 200 micrograms per cubic

meter of air, 24-hour average, not to be exceeded more than once per year.

(b) Annual average: 75 micrograms per cubic meter of air, annual average, not to be exceeded.

(2) Measurement method: For determining compliance with this rule, total suspended particulate matter shall be measured by the high volume method as more fully described in Title 40, Part 50, (Appendix B) Code of Federal Regulations (1979), or by an approved equivalent method.

RULE XIV AMBIENT AIR QUALITY STANDARD FOR VISIBILITY

(1) No person shall cause or contribute to concentrations of particulate matter such that the scattering coefficient of particulate matter in the ambient air exceeds the following standard:

(a) Annual average: 3×10^{-5} per meter, annual average, not to be exceeded.

(2) The provisions of subsection (1) are applicable only in Class I areas as are and as may be designated under ARM 16-2.14(1)-S1418, Prevention of Significant Deterioration, of the Montana Clean Air Act rules.

(3) Measurement method: For determining compliance with this rule, visibility shall be measured by the integrating mephelometer method, as more fully described in "Methods of Air Sampling and Analysis, Second Edition" (1977) Method No. 11203-03-76T, as modified by the addition of a heated sample inlet line and green spectral sensitivity; or by an approved equivalent method.

16-2.14(1)-S14041 PROCEDURES FOR HEARINGS ON PROPOSED AMBIENT AIR QUALITY STANDARDS The following procedures shall be followed with respect to the hearings before the Board of Health and Environmental Sciences and its presiding officer for the establishment of ambient air quality standards in the State of Montana:

(1) The testimony of interested parties shall be prefiled within thirty (30) days after the date of mailing of the final environmental impact statement, with copies going to all parties on the service list. Thereafter, within forty-nine (49) days all responses thereto shall be prefiled with the Board or its presiding officer. The prefiling of direct testimony and response testimony applies to both expert witnesses and policy witnesses, if any.

The opening statements of the direct testimony or responses thereto must contain a description of the witnesses' qualifications. The description of qualifications shall include but not be limited to the following:

(a) Educational background and experience;

(b) Description of any post-graduate training and professional career since graduation;

(c) Identification of pertinent publications authored by the witness; and;

(d) A disclosure of group representation, if any.

(2) Rebuttal statements to responses, to opening statements and to any testimony presented by the parties or expert witnesses at public hearing must be filed within forty-five (45) days after the date upon which the public hearings are closed.

(3) All statements must be made under oath.

(4) Cross-examination shall not be permitted except by the presiding officer or any Board member.

(5) Witnesses and parties with prefiled opening statements or responses shall be subject to the call of the presiding officer or the Board to attend any public hearing for questioning by the presiding officer or Board members.

(6) A schedule for the appearance of any such witness will be prepared by the presiding officer or the Board which will identify each witness and the party that he represents; and the date upon which said witness is expected to appear for questioning. Copies of such schedule will be provided all names of the service list.

(7) Even though all expert witnesses are required to prefile their statements and/or responses to opening statements, it shall not be a requirement that a party or expert witness shall have filed opening statements in order to file a response to opening statements. All parties or expert witnesses who have filed opening statements or responses to opening statements shall be entitled to file rebuttal statements as hereinabove provided.

(8) Rules of discovery shall not be applicable to these proceedings. Discovery among the parties or expert witnesses shall not be permitted. The order of contaminant or pollutant will be addressed at the public hearings as follows: Sulfur dioxide (SO_2), total suspended particulates (TSP), fluorides (FL), urban pollutants, heavy metals and hydrogen sulfide (H_2S).

(9) A period for public comment will be set aside at the end of all testimony. The public is entitled to attend any and all sessions. The presiding officer will be authorized to take public testimony at his discretion if there if justification therefor.

(10) The Notice of Hearing shall require that a service list containing all parties be provided.

(11) Written testimony shall be accompanied by a summary of its subject matter, approximately 100 words in length. (History: Sec. 75-2-111, 75-2-202, MCA; NEW, 1978 MAR p. 1459; Eff. 1/26/79; AMD, 1979 MAR p. 319; Eff 3/30/79.)

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